NATURE

No. 4101 SATURDAY, JUNE 5, 1948 Vol. 161

CONTENTS

	Page
Science and History	865
Development of Radar. By Sir Robert Watson-Watt, C.B., F.R.S.	867
Landscape Architecture. By Prof. L. Dudley Stamp	868
Research on Management. By E. F. L. Brech	869
Humour and Humanism in Chemistry. By Denis I. Duveen	869
Biochemistry in Progress	870
Local Government and the Citizen. By Lieut.-Col. Eric Lowe	870
Significance of Nuclear Change in Differentiation. By Dr. K. Mather	872
Biological Aspects of Water Pollution	874
The Royal Academy, 1948. By Dr. A. Tindell Hopwood	876
Obituaries :	
Dr. H. W. Richmond, F.R.S. By Prof. E. A. Milne, M.B.E., F.R.S.	877
Prof. P. A. C. Dangeard. By Dr. B. Barnes	878
News and Views	879
Letters to the Editors :	
Meson Scattering with Nuclear Excitation.—Dr. H. J. Bhabha, F.R.S., and R. R. Daniel	883
Investigation of the Radioactivity of Rocks by the Photographic Method.—Dr. J. H. J. Poole and J. W. Bremner	884
Lightning Arrester Discharge Currents.—Robert C. Cuffe	885
Effect of Lattice Distortions on the Mean Rate of Propagation of Large Barkhausen Discontinuities.—Dr. L. J. Dijkstra and Dr. J. L. Snoek	886
Metastable States of Nickel Characterized by a High Initial Permeability.—Dr. J. L. Snoek and J. F. Fast	887
Audio-Frequency Magnetic Fluctuations.—H. F. Willis	887
Structure of Plasteins.—Prof. Artturi I. Virtanen and Heikki K. Kerkkonen	888
A Synthesis of Fluoranthene Derivatives.—Dr. E. Bergmann	889
Chemical Mechanism of Permanent Set.—A. J. Farnworth and Prof. J. B. Speakman	890
Energy of the Central C—C Bond in Diphenyl.—Dr. M. Szwarc	890
Stress Corrosion.—J. C. Chaston	891
Podocarpic Acid as a Source of an Œstrogenic Hormone.—C. W. Brandt and D. J. Ross	892
Isomerization of Dienœstrol.—W. Hausmann and Dr. A. E. Wilder Smith	892
Glycerol Dichlorhydrin and Vitamin A.—D. D. Penketh	893
Pressor Effect of Renin on Pulmonary Artery Pressure.—E. G. Brewin, R. A. Kenney and D. H. Miller	893
A Culture Method for *Lymnaea truncatula*.—E. L. Taylor and Alan Mozley	894
Resistance to 'Inanition' in Grass Seedlings.—J. P. Cooper	894
Occurrence of Volcanic Bomb in the Agglomeratic Slates of Kashmir.—Dr. R. C. Misra	895
Proposed Central Publication of Scientific Papers.—Watson Davis	896
Mesons and Nucleons. By Prof. O. Klein	897
Excitation Curves for the γ-Radiation from Light Elements Bombarded with α-Particles from Polonium. By Prof. Hilding Slätis	899
Reactivity and Structure of Molecules. By Prof. F. A. Paneth, F.R.S.	901
Fauna and Flora of Palestine	902
Afforestation as a World Problem	902
South African Council for Scientific and Industrial Research	903

Editorial and Publishing Offices
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number : Whitehall 8831
Telegrams : Phusis Lesquare London

Advertisements should be addressed to
T. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2
Telephone : Temple Bar 1942

The annual subscription rate is £4 10 0, payable in advance, Inland or Abroad

All rights reserved.

Registered as a Newspaper at the General Post Office

SCIENCE AND HISTORY

THE plea for a historical approach in teaching science which Dr. J. B. Conant advanced in his Terry Lectures at Yale University, which have now been published under the title "On Understanding Science"*, raises questions of interest to many besides those who are concerned with teaching itself. Dr. Conant is indeed urging the use of case-histories in teaching science, and illustrates his proposal by the specific example of seventeenth-century experiments on the 'spring of the air' with barometers, air pumps and vacua to show the influence of new techniques, the evolution of new concepts from experiment, the difficulties of experimentation and the significance of the controlled experiment, and the development of science as an organised social activity. These points are further emphasized by a study of the discovery of the electric battery and of the chemical revolution which placed our knowledge of combustion on a sound basis, in which he shows further how an accidental discovery may lead by a series of well-planned experiments to a new technique or a new concept, or both. In exploring a new phenomenon, the experiments may be well planned without any working hypothesis as to the nature of the phenomenon ; furthermore, a useful concept may even be a barrier to the acceptance of a better one if it be long entrenched in the minds of scientific men. Experimental discoveries, he believes, must fit the times ; facts may be at hand for years without their significance being realized ; the total scientific situation must be favourable for the acceptance of new views.

These principles in the tactics and strategy of science are of great importance in the education of the scientific worker himself, and it might be urged that they should be considered with special care by those responsible for the training of the social scientist. They are equally important for the education of the layman, and in conveying to him a clear understanding of what science can and cannot accomplish, and how it works ; for on such understanding the smooth functioning of a democracy largely depends. Dr. Conant argues cogently that, in this way, by clarifying popular thinking about the methods of science, as well as by assisting those in positions of authority and responsibility and those who shape opinion to gain some understanding of science, we should go far to lay the basis for a fruitful discussion of the ways in which rational methods may be applied to the study and solution of human problems.

Even if that is claiming too much, there can be no doubt as to the value of the historical approach in assisting a better understanding of natural science among laymen, or of the importance of such an understanding for the promotion of national welfare. A greater knowledge of the genesis of certain habits of mind should, as Dr. Conant suggests, reinforce slowly but persistently those habits of mind and those rational elements in our civic life which make for the adventurous yet orderly development of our

* On Understanding Science. By Dr. J. B. Conant. Pp. 162. (London : Oxford University Press, 1947.) 10s. 6d. net.

free society. Dr. Conant makes no extreme claims for the widespread application of the scientific method to the problems of society at every level: he recognizes its limitations, and questions, indeed, the validity of Karl Pearson's assertion that "modern science, as training the mind to an exact and impartial analysis of facts, is an education specially fitted to promote sound citizenship"; indeed, he holds that those who have little or no direct experience with scientific investigations might be completely misled as to the nature of the scientific method by studying "The Grammar of Science".

What Dr. Conant is concerned to promote is just that understanding of the way science works, its difficulties and limitations, which will prevent the distortions which arise when the man of science is put on a pedestal and his activities are regarded as something mysterious or even magical and apart from the ordinary activities of mankind. Incidentally, these few pages are much more suggestive and stimulating in their brief reference to professional tradition and discipline and the role of the learned societies in science, as well as in society as a whole, than some of the lengthy but subjective volumes which other authors have devoted to these matters.

Dr. Conant goes right to the heart of the problem of the relation of knowledge to power. He sees clearly that if science is to be used wisely and to take its place among the ordinary activities of mankind, the idea of mystery or magic must be cleared away from the minds of the people. Indeed, so long as any such idea lingers in the popular imagination, the danger of a violent reaction against science and of the social throttling of research, of which Glenn Frank and others have warned us, will persist, and that danger is as great among the Western nations as it is among the more backward peoples.

It is a great merit of the historical approach that it facilitates apprehension of the social implications of science, and there is a passage in the recently issued report on Education for Citizenship in Africa prepared by the Colonial Office Advisory Committee on Education in the Colonies which is strikingly in line with Dr. Conant's thesis. It is not merely among the Colonial peoples that the lesson needs to be learned that man's power over Nature is obtained only by studying and using the facts, and that facts will not consent to adapt themselves to fit a man-made theory; or again, that we should consider the problem of the relationship between the intellectual and the spiritual sides of man's life, between the science of acquiring knowledge and the art of using it.

Burke once reminded us that we do not draw the moral lessons we might from history; and those who realize most fully the extent to which man's material advance has outstripped his spiritual progress have asked with reason whether anything could do more to help to recapture moral control than the universal recognition that physical science belongs in essence to the humanities, is a part, and may become the most important part, of that body of teaching which, though once narrowly confined, was always destined to expand and in unity to embrace the obligations of the good life. In that suggestion, Mr. J. B. Atkin in a recent book, "Incidents and Reflections"*, goes beyond Dr. Conant's arguments; but he is much more convincing than those who, like Dr. G. M. Trevelyan, reject entirely the idea of history as science and contend that history is more a matter of rough guessing from all available facts, dealing with intellectual and spiritual forces which cannot be subjected to scientific analysis, while at the same time they claim that the study of history instils the habit of surveying broadmindedly and calmly the pageant and process of human affairs. It is true, as Dr. G. G. Coulton once remarked, that the more we divorce history from the common life of man, the more we strangle its own vigorous life; but it is equally true that the historian can give no real guidance unless he proceeds from the assembling of facts to generalizations and from generalizations back to facts.

In the simplest and most fundamental way, historical method and scientific method are one and the same, as Mr. A. L. Rowse points out, and the scientific worker concerned to use the historical approach to science or interested in the relations of science and history might do worse than study the two chapters in Mr. Rowse's little book "The Use of History"†, where he brings out the ultimate reason why the study of history and of science is so vital at the present time.

Mr. Rowse suggests tentatively that in spite of all sorts of disillusionments and setbacks, there is an irresistible impulse towards self-government in human society, and he draws the general conclusion from European history that no one power is strong enough to rule all the rest. The sense of history therefore, he suggests, indicates some federal system that may enable us to work together in co-operation. Events in Europe since Mr. Rowse wrote those words in 1945 seem to support the brave assumption that on the basis of a knowledge of history we can look into the nearer future and see something of the shape of things that is emerging, and that such knowledge is the best aid to knowing what we can usefully achieve in our turn.

Mr. Rowse makes that assumption a little too readily, but if the project for a Western Union in Europe is to take concrete shape, the combination of the historian and the man of science, of the historical and the experimental method, may be indispensable. From one must come some guidance as to the behaviour of human groups and the working of human institutions; from the other, and especially the social scientist, must come the closer study of such groups and of individuals in the context of modern society. But both alike will require that the scientific approach be accompanied by the imaginative insight and understanding that marks the great historian no less than the great scientist, if they are to yield their full contribution to the shaping of the new institutions which the world needs to establish order and safeguard its great heritage of freedom and

* Incidents and Reflections. By J. B. Atkin. Pp. 258. (London: Christophers, 1947.) 12s. 6d. net.

† The Use of History. By A. L. Rowse. Pp. xi+247. (London: Hodder and Stoughton, Ltd., 1946.) 4s. 6d. net.

culture from the danger of destruction in war. The historian's work, like that of the man of science, must be sensitive to those human undertones and values which give life its dignity and purpose, and without which the human spirit droops and loses its creative power.

We need to remember that history is a matter of sense as well as of science, and of feeling as well as of fact; and that both will be required no less in the exercise of citizenship than in the practice of management and administration. We cannot understand why men acted in a certain manner unless we know how they felt; and in discovering where men failed in sympathy and understanding because of such ignorance, we come to the realities of history and indeed of politics, in the widest sense, upon which not merely good citizenship but also good management and administration, and indeed the organisation to serve a new world order, must be based. The historical approach to science helps us to see science in its true perspective in relation to those problems; just as the study of history inculcates that discipline and insight through which alone man can acquire the wisdom and self-command to evolve the forms of organisation which will serve his needs to-day, in industry, in the relations of one nation with another, and in society as a whole.

DEVELOPMENT OF RADAR

Radar System Engineering

Edited by Prof. Louis N. Ridenour. (Massachusetts Institute of Technology, Radiation Laboratory Series.) Pp. xviii+748. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 37*s*. 6*d*.

THOSE who had the privilege of participating in "the tremendous research and development effort that went into the development of radar and related techniques during World War II" are often asked about the effects of that effort in peace-time applications. The effects are of two kinds. The direct use of radar in increasing the safety, speed and economy of transport by air, sea and (perhaps) land is generally appreciated, widely understood and, not infrequently, too optimistically appraised. The indirect effects of radar development or more general radio development are less fully recognized outside specialist circles. Yet it is almost certainly true that these indirect effects will be more important than the direct peace-time applications; they may indeed be comparable in importance to the contribution of radar to victory in the War.

The full benefits of the imaginative skill and initiative, and the 'expertise' which produced, *inter alia*, "the basic microwave and electronic theory and techniques that had been so thoroughly developed during the war-time work on radar" could not be reaped without the further efforts of a distinguished group of the physicists and engineers concerned. The great Radiation Laboratory at the Massachusetts Institute of Technology was itself a monument of scientific co-operation in a great cause. It leaves, as its written memorial to the comparatively few whose names have been quoted in accounts of radar development, and to "the unnamed hundreds and thousands of other scientists, engineers and others who actually carried on the research development and engineering work", a new 'Five-Foot Shelf' not unworthy of a place below the original five-foot shelf of the 'Hundred Best Books'. The generous co-operation of an editorial-cum-author group of about sixty members, which remained at the Massachusetts Institute for more than six months after they might reasonably have chosen to return to their normal peace-time pursuits, and which was supported by a still larger body of contributing authors, has given us a twenty-eight volume series of which Prof. Louis Ridenour's "Radar System Engineering" is, appropriately, the first volume. Appropriately, because the five books dealing with radar and allied systems, and the twenty-two books dealing with special techniques, circuits and circuit elements, which with a twenty-eighth index volume fill the five-foot shelf, all spring from the parent stem of "Radar System Engineering", and are all contributing to the synthesis of radar engineering. The author's preface remarks that this volume serves to specialize to radar the techniques which are described in other volumes of the series.

Ridenour's book will continue to be the best book on the subject when the present and still too thin first crop of books on radar and allied topics has greatly increased. It is an admirably full and balanced survey, at once a general treatise substantially complete in itself, a reference book on design and a guide to the use of the more detailed but more closely canalized papers which are now being added to the tool-kit of the radio worker.

No comparable work has been published, or appears to be contemplated, in Great Britain. The only substantial body of published work on radar yet published in the United Kingdom is contained in the proceedings of the highly successful and stimulating Radiolocation Convention of the Institution of Electrical Engineers, supplemented by a few isolated volumes on special subjects. The British *ensemble* still falls short of being a balanced and comprehensive whole. The American *ensemble* has the enormous advantage of having been carefully planned, before execution, to ensure balance and completeness. It has the major merits, as well as the minor blemishes, of an enterprise in which the whole series is the work of a co-operative team, and in which the typical volume, like the volume under review, is itself the product of a team of authors, each an authority on the subject of which he writes. In the planning, the editing and the writing, the Radiation Laboratory team had the cordial co-operation of their British colleagues, and the author-writer of this volume acknowledges in particular the help of Dr. B. V. Bowden.

If the team method has produced some unevenness in standard, the lowest standard is still high and the average remarkably high. The section on the "Properties of Radar Targets" has no adequate counterpart in British published papers, and that on the "Minimum Detectable Signal" may be cited as an exceptionally searching synthesis of fundamental considerations in design.

The book is extremely well illustrated, and the wealth of photographs of P.P.I. (Plan Position Indicator) displays illustrating a great variety of technical and operational points of importance make a fascinating and excellent album of modern radar.

The book contains much the best, and indeed the only reasonably comprehensive account of the tech-

nique developed, in the latter stages of the War, for discriminating between the usually desired responses from moving targets and the usually, but not invariably, undesired responses from substantially fixed targets. This technique of 'moving target indication' will be of great importance in peace-time radar, as, for example, in maintaining continuous observation on civil air traffic by elimination of the 'ground clutter' of 'permanent echoes' which obscure or overlay aircraft echoes.

There is another 'clutter' phenomenon which imposes grave limitations on the general use of radar. The return of radar echoes from rainstorms is a well-known and quantitatively understood cause of impairment of radar search and surveillance. The general problem is well treated in a brief section which ends with a tantalizingly brief indication of results obtained by utilizing, as a discriminant between rain echoes and the echoes from ground targets, the fidelity with which the polarization of the incident radiation is retained in returns from spherical drops, as opposed to the changes in polarization produced by the ground targets. A fuller quantitative account of observations in adequately diverse conditions especially with echoes from aircraft would be welcomed by all radar workers.

This problem of rain-clutter is one, but only one, of a variety of considerations which lead to the only major criticism that can be levelled against the content of a volume entitled "Radar System Engineering". The editor-author says in his preface, "This book is intended to serve as a general treatise and reference book on the design of radar systems. No apology seems to be needed for the fact that it deals primarily—though by no means altogether—with microwave pulse radar. Thousands of times as much work has gone into pulse radar as into any other kind, and the overwhelming majority of this work has been concerned with microwave pulse radar. The superiority of microwaves for almost all radar purposes is now clear." What he means by "microwave" is clear; he means wave-lengths less than ten centimetres. What he means by "almost all radar purposes", if we are to agree with his conclusion, is much less clear. The variety of considerations referred to a moment ago may be journalistically summarized as ranging "from raindrops to V2". Nor was it merely the accidents of time and place that made a large majority of the radar equipment used in the final liberation assault on Europe work on wave-lengths greater than 10 cm.

The truth is that microwave radar is of extreme importance in a majority of all radar operations, but that radar equipments working on wave-lengths from 30 centimetres to about 10 metres are indispensable for operations of crucial importance which cannot be assured even by microwave radar.

There is, throughout the book, a generous and cordial appreciation of the British contributions to the development and application of radar in war. That generous cordiality has always characterized opinion at the Massachusetts Institute of Technology through all the variations of emphasis found elsewhere in discussions on radar history. It may be suggested that the Radiation Laboratory view is most happily enshrined in the emblem adorning the cover and the title-page of each volume in this impressive and satisfying series. The emblem shows the picture of a characteristic and cherished part of New England, the Cape Cod area, displayed on what even a Scottish reviewer may allow himself to describe as one product of Old England, the Plan Position Indicator, all surrounded, enshrined and defended by another product which its Australian-born inspirer would also gladly admit as a product of Old England, the anode of a resonant cavity magnetron. And integrally knit into this symbol of American-British interdependence in progress is the name of the great institution of which all British radar workers are as justly proud as are the American, the "Radiation Laboratory M.I.T., Cambridge, Mass., 1940–1945".

The book has few—remarkably few—errors; they will not mislead, and they will be corrected in the second edition which will certainly be demanded; they are negligible brush marks on a brilliantly successful piece of co-operative authorship. We join with the distinguished leader and inspirer of the Radiation Laboratory, Dr. L. A. Du Bridge, in the sense of his foreword: "to all those who contributed in any way to this great cooperative development enterprise, both in this country and in England, these volumes are dedicated". The monument is worthy of those to whom it is dedicated—and they were a great army of great men.

ROBERT WATSON-WATT

LANDSCAPE ARCHITECTURE

Land and Landscape

By Brenda Colvin. Pp. xii+266+106 plates. (London: John Murray, 1948.) 21*s.* net.

THE scenery of a long-settled country such as Britain is the result of the action and interaction of several factors. The background is provided by the relief and drainage of the land, the natural and semi-natural vegetation; the broad aspect is the result of economic use in the production of food and raw materials; but in detail the scenery is the result of man's conscious activities in the lay-out of his homes and their surroundings.

The term 'landscape architecture' is now commonly applied to work which is at once a science and an art. In planning a garden, small or large, still more in planning such an extensive area as an estate, the landscape architect requires to know and understand the scientific laws which have determined the surface form of the site and its vegetation cover before he can introduce those elements of design in which he uses living plants in order to obtain the desired effect. While it may be true that the formal garden never obtained quite the vogue in Britain which it had on the Continent, Britain abounds in mature examples of the work of landscape architects, especially those who laid out the great estates with their avenues of trees and their vistas, and which we associate particularly with the mansions built in the later part of the eighteenth century. Many of these carefully planned estates are to-day jealously guarded as part of our national heritage. Among the examples included in the album of photographs of Miss Colvin's volume we notice Blenheim and Chatsworth, but she does not forget to remind us that beech clumps on the chalk, such as Wittenham, or the informal landscape setting of Dinton House are also examples of landscape architecture, and she further reminds us that in detail the rock garden or the peculiarly English art of topiary must also be included.

Miss Colvin's book treats of a subject which it is extraordinarily difficult to expound, since it needs the

clear understanding of the scientific principles involved on one hand and a balanced assessment of the æsthetic results on the other. Fashions change as much in landscape architecture as in architecture itself. Yet without attempting to decide between one style and another, there is at least a partial agreement on what constitutes 'good manners' in the treatment of landscape as there is in architecture.

In reading Miss Colvin's book one feels that behind a welter of words she is attempting to convey to the reader a philosophy which should underly any work of execution. One can learn much from having one's thoughts directed to some of the many examples she illustrates and describes; but the scientific reader will feel that she has failed to appreciate the meaning and influence of the natural laws which must govern the work of the landscape architect, and he is likely to show only impatience at what he may call a sentimental and subjective approach.

The book deserves the credit of being a pioneer in a difficult field. One would like to see a future development along the lines of a more adequate treatment of the scientific principles involved.

L. Dudley Stamp

RESEARCH ON MANAGEMENT

The Board of Directors and Business Management

By Melvin T. Copeland and Asst. Prof. Andrew R. Towl. Pp. xiii + 202. (Boston, Mass.: Harvard University, Division of Research, Graduate School of Business Administration, 1947.) 3.25 dollars.

In view of the widespread official and public interest in management as an important contributor to the solution of contemporary economic problems, it is to be regretted that so little has hitherto been done to ensure that the practice of management should be adequately supported by research. The controversy whether 'management' is a science or an art is largely academic and many people find it idle. Whatever its character, knowledge of the principles and methods of management, and improvements in its practice, can be obtained only from the collation and interpretation of experience, supplemented by systematic research. This is the approach customarily pursued in the natural sciences, and its value to the social sciences in general and to management in particular is more readily recognized in the United States than in Great Britain.

Copeland and Towl's book is evidence of the readiness of American universities and business corporations to collaborate in the conduct of research. It is a report on a research project; not one that has been carried out in an academic setting in terms of pure theory, but a practical investigation of certain aspects of higher management conducted in the setting of real life. The study starts from recognition of the fact that "a business corporation is inherently a social undertaking, in which several groups and divers personalities are assembled to work together to their mutual economic advantage". Among such groups is the board of directors, the group charged with responsibility for the formulation of policy and for the overall direction of the activities of the enterprise.

The different legal framework of American and British industry necessarily entails certain differences in the position and outlook of directors, but in the main the study resulting from this research is as pertinent and as valuable to British conditions as to those on the other side of the Atlantic. It can be briefly described as a review of most aspects of the functions of the board of directors, and of their attitude to their duties. It brings out clearly their primary responsibility for the formulation of policy, and stresses the corporate character of the board. The difference between a director as such and an executive in the organisation is also well brought out, and special attention is paid in later chapters to correcting misconceptions, as well as unfolding the 'unpleasant' tasks within the director's domain. So far as British conditions are concerned, the two common misconceptions of a director holding executive functions, and of a board being the gathering point for big names, are clearly diagnosed.

The authors round off their study by a chapter entitled "Some Questions which a Director may well ask himself". This is a factual list revealing the extent to which the research project was bedded in the actual practice of directors at work in a variety of industrial organisations.

The book can be safely recommended as a valuable contribution to literature, of value to the practising director, to the younger senior executive who has aspirations to the board, and even to those who are studying management as a matter of interest rather than preparing themselves at the moment for its higher levels. Perhaps the reviewer's only regret is that this particular study has come from American sources rather than British.

E. F. L. Erech

HUMOUR AND HUMANISM IN CHEMISTRY

Humour and Humanism in Chemistry

By Prof. John Read. Pp. xxiii + 388 + 47 plates. (London: G. Bell and Sons, Ltd., 1947.) 21*s.* net.

As the author points out in his preface, "Humour and Humanism in Chemistry" is divided into three sections, the first two being approximately equal in length and dealing with alchemy and "chymistry", which the author defines as the transition from alchemy to chemistry, respectively. The last section deals with the chemistry of the late eighteenth and nineteenth centuries.

The first five chapters, which are concerned with alchemy, may be considered as an appendix to Prof. Read's "Prelude to Chemistry"; and they contain further interesting details and some expansion of matters already touched upon in the earlier work. There has been a tendency to ridicule alchemy and the alchemists; but however misguided some of them may have been, there is no doubt that important empirical discoveries were made by them, and they form a vital link in the chain of development by which chemistry graduated from an art to a science. The author shows understanding and sensitivity when dealing with these early workers.

The next two chapters (6 and 7) deal with such seventeenth- and eighteenth-century chemists as Jean Beguin, William Davisson, Johan Glauber, Nicolas Le Febure, Christopher Glaser, Nicolas Lemery and Herman Boerhaave. Prof. Read gives an account of the life and personality of each of these "chymical artists" and then details their main contributions to the literature of chemistry, with an analysis of the contents and relative importance of the works in

question. This section of the book is particularly interesting, and is valuable because it stresses an important period in the development from alchemy to chemistry and shows how this development can be traced in the text-books written by these men.

The third and largest section of the book contains a wealth of interesting information but suffers somewhat from being disjointed. It opens with an account of Joseph Black's contribution to chemistry, and passing by way of Madame Marcet and her oft-reprinted text-book, leads up to a description of nineteenth century student life in the laboratories of the great masters Liebig, Bayer and Werner at Giessen, Munich and Zurich. A sympathetic evaluation of Sir William Pope's work and a good account of the man himself is followed by a chapter on Australia, dealing largely with the various eucalyptus trees indigenous to that country and the chemistry of the essential oils obtained from them. Finally comes an entertaining flight of fancy in the form of a "Chemic Drama in One Act".

The book, written in Prof. Read's customary charming style, is well produced and lavishly illustrated.

DENIS I. DUVEEN

BIOCHEMISTRY IN PROGRESS

Annual Review of Biochemistry

J. Murray Luck, Editor; Hubert S. Loring, Associate Editor; Gordon Mackinney, Associate Editor. Vol. 16. Pp. xi+740. (Stanford University P.O.: Annual Reviews, Inc.; London: H. K. Lewis and Co., Ltd., 1947.) n.p.

THIS series of volumes continues to need no stimulus to its sales; all biochemists buy it or see it, or ought to. For the most part, as in previous years, the review for 1947 proceeds along familiar lines, with articles on biological oxidations, the chemistry and metabolism of the major foodstuffs, mineral metabolism, vitamins, hormones, and so on. But the editors always take care to vary the staple diet with something uncommon, and this year the 'bakemeats' include choline, anti-oxidants, animal biochromes (pigments to most of us, and why not?), folic acid, anti-malarial drugs, and marine bacteriology. There is thus no lack of variety in subject-matter, which is treated throughout in the critical manner that reviewing of this kind demands, but does not always get.

Limitation of space does not allow the majority of the reviewers to go beyond their set task, that of discussing all the published work which has appeared since the last "Review"; all the more welcome, therefore, is an article on the use of isotopes in biochemical research, in which the snags of some methods, and the advantages of others, are freely and frankly canvassed on a platform of recent experiment, to the great profit of any reader who does not happen to be an expert in this field. It is to be hoped that this article is not the last of its kind.

The standard of the "Review", both in reporting and editing, is now so high that considerable suggestions for improvement are scarcely possible. But perhaps the editors might care to consider one small item. The bibliography attached to each article is so very useful to anybody wanting a quick conspectus of the subject that alphabetical arrangement of the authors would be an advantage. For the "Review" is not ephemeral, to be laid aside when the novelty of the contents has worn off; the back numbers are consulted by writers of books, papers and lectures, and much time can be consumed in searching through two hundred names for a single reference. It is true that some may prefer a bibliography to be arranged in the order of appearance of the references in the text, and for any but works of reference this system has much to commend it. But the "Review" is a work of reference. Already some of the articles have bibliographies alphabetically arranged; if some, why not all? Doubtless the point has been made before, and anyhow it must not be allowed to stand between editors and reviewers and our thanks.

LOCAL GOVERNMENT AND THE CITIZEN

Local Government

By Sir A. S. MacNalty. (Home Study Books.) Pp. x+222. (London: Methuen and Co., Ltd., 1948.) 4s. 6d. net.

IN the new series of Home Study Books designed, under the general editorship of Dr. B. Ifor Evans, to cover "the most significant aspects of modern thought and investigation", two major considerations may be held to justify the inclusion of "Local Government" among the first seven titles: the close relationship between local government activity and the daily life of the citizen, and the negative attitude of a large proportion of the community towards the management of local affairs. Written with the view of assisting "men and women who are interested in the subject and who may be inclined, either as members or officials of local authorities, to devote their gifts to this important branch of national work for the common weal", this volume carries the insistent message that the effective co-operation of the private citizen is vital to progressive administration at local government level.

Since the book was written, developments have already taken place in the system of local government, and far-reaching changes are, of course, impending, such as those foreshadowed in the recently published second annual report of the Local Government Boundary Commission. The trend of such developments is discussed in a short final section on the future of local government, but the author's major purpose is to provide a historical background against which change may be seen in true perspective. The treatment, though authoritative, is not intended to be exhaustive, and since the book is "neither a textbook nor a legal treatise" the author delivers his own views on a number of live issues. He can fairly claim to have provided a comprehensive survey of the growth, structure and functions of local government, and the serious student will certainly want to add this book to his collection. It will perhaps be particularly valued for the special interest of the section on public health, in which the author's own experience speaks most clearly.

One curious omission may limit the book's appeal. Not a single chart, diagram or other form of graphic representation is used, although the subject so obviously lends itself to treatment of this kind. The average man or woman has grown to expect such aids, and the author who neglects to employ them when addressing the general reader places himself at an initial disadvantage.

ERIC LOWE

The Atom

By Sir George Thomson. (Home University Library of Modern Knowledge, 145.) Third edition. Pp. viii + 196. (London: Oxford University Press, 1947.) 5s. net.

THIS is neither a text-book nor a 'popular' work, but a book of genuine educational value, in which present knowledge of atomic and nuclear physics is simply but clearly set forth, backed by the historical perspective of earlier ideas, and looking forward to the resolution of present difficulties by further experimental and theoretical development of the subject.

The writing of such a book demands nice judgment and strong determination to hold the balance between facts and theories, and to give no more than proper prominence to those parts of the subject that catch the imagination of the amateur. Sir George Thomson, as in previous editions of the book, has done this admirably and has given, in eighteen short chapters, a remarkably complete outline of modern knowledge of atoms and the electrons and nuclei that are their constituent parts. He never forgets that atoms are fundamental to chemistry as well as to physics, and the chapters on crystal structure, "The Atom in Chemistry" and "The Electron in Chemistry", are among the best in the book.

"The Atom", though quite an elementary book, deserves and indeed demands careful reading. Like the others in this series, it is meant for those who are prepared to think as well as to read. The thoughtful reader will not be satisfied with all the explanations of atomic phenomena that are offered; that is as it should be, for there are plenty of unsatisfying features in current theories. Sir George himself does not hesitate, on occasion, to envisage the overthrow of the views he is expounding; for example, he ends his discussion of the inherent limitations of physical measurement by speculating on "a probe more delicate than an electron", immune from its wave-like properties that he himself has done so much to establish and to use. P. B. M.

Radio Data Charts

A Series of Forty-four Abacs providing most of the Essential Data required in Receiver Design. By Dr. R. T. Beatty. Revised by J. McG. Sowerby. Fourth edition, second impression. Pp. 93. (London: Iliffe and Sons, Ltd., 1947.) 7s. 6d. net.

THESE charts present in nomogram form the solution to many of the problems met with in the design of radio receivers and similar apparatus. The explanatory text accompanying each chart is brief but clear, and not only gives the formula upon which the chart is based but also provides a general background to the problem. The method of use of each chart is fully explained by means of a key and is illustrated by examples.

In this fourth edition five new charts have been added. One enables the frequency response of single tuned and band-pass circuits to be determined; another gives the coupling coefficient of intermediate frequency transformers; and a third the resonant impedance of a quarter-wave line. The other two are concerned with the design of resistance-coupled amplifiers. Of the remaining charts, five cover the interrelation between inductance, capacity and frequency in resonant circuits over a wide range of values and another group deals with the design of radio-frequency coils, including the effect of screening cans. Assistance in the design of mains transformers and chokes, output transformers, transmission lines and resistance attenuators is also provided. Data on the D.C. resistance of wires, the power dissipated by a resistance and the reactance of coils and condensers, together with scales for the conversion of frequency to wave-length and ratio to decibels, complete this comprehensive collection of 'abacs'.

The main features of this volume which commend it to the radio engineer are the ease and speed with which design problems can be solved and the way in which the effect of changes in the values of the parameters involved can be readily determined.

B. G. P.

Modern Magnetism

By Prof. L. F. Bates. Second edition, revised and enlarged. Pp. xi + 440. (Cambridge: At the University Press, 1948.) 25s. net.

BATES'S "Modern Magnetism", first published in 1939, is widely appreciated as a general survey in which adequate attention is given to the experimental side. In preparing a second edition, the author's aim was that it should be reasonably up to date. Unfortunately, "the difficulties of the times made large-scale alterations of the existing pages impracticable", and the bulk of the new material, mostly on work published since 1938, is collected in six additional chapters, occupying about a hundred pages. These chapters deal with a wide variety of topics falling under the general headings of hysteresis, ferromagnetic substances, weakly magnetic substances, radiofrequency spectroscopy, adiabatic demagnetization, and paramagnetic absorption and dispersion. In view of the author's notable contributions in some of these fields, particular interest is attached to his presentation of cognate work; and the chapter on radiofrequency spectroscopy provides almost the only recent short survey of the elegant techniques applied in determining nuclear moments. The treatment in the new chapters is, no doubt deliberately, somewhat uncritical; and the 'adding on' of the miscellaneous new material inevitably leads to some lack of coherence in the book. It is much to be hoped that conditions will later enable the author to reshape the book into an artistic whole. For the present, however, many readers will be most grateful to the author for collecting together so much interesting information about recent work in magnetism. E. C. S.

The Romance of Rhodesia

Being the Impressions of a Sight-seeing Tour to Southern and Northern Rhodesia *via* Seychelles, Mombasa, Zanzibar and Dar-es-Salaam. By Ardaser Sorabjee N. Wadia. Pp. xiv + 146 + 16 plates. (London: J. M. Dent and Sons, Ltd., 1947.) 21s. net.

MR. WADIA'S ready pen has this time been turned to describe a tourist trip to Rhodesia that was made before the War. He departed rarely from the conventional tourist route, and his brief sketch contains little that is new in factual information. Mr. Wadia touches frankly, however, on many of the problems that Rhodesia and other parts of Africa have to face. Thus he has reflexions on racial discrimination, the colour problem, the scope of missionary endeavour, and especially of the problem of Indians in South Africa. Generally he is critical of existing relations between races, but supports British rule. His criticisms are worthy of attention. The book is beautifully illustrated.

SIGNIFICANCE OF NUCLEAR CHANGE IN DIFFERENTIATION

By Dr. K. MATHER
John Innes Horticultural Institution, Merton

IN the process of differentiation, cells derived from a common ancestral cell take on different, though mutually adjusted, forms and functions. Some determinants must therefore change during this process in either the cytoplasm or the nucleus, or, of course, both. The genetical problem of differentiation is to discover what the properties of these determinants are, and how they are related to those other determinants, the genes, the permanency of which we recognize by their transmission from generation to generation in sexual reproduction.

There is a growing body of evidence that differentiation is at times, though by no means always, accompanied by changes in the nucleus. These changes appear to be of three main kinds: changes of elimination, replication and manifestation.

Changes of elimination involve specific whole chromosomes or specific parts of chromosomes, in which latter case the process is more commonly called diminution. Elimination is a rare occurrence, most cases being known in the Diptera[1]. In *Ascaris*, where the process is properly diminution, it affects every chromosome at the second to fifth cleavage divisions in those cells ancestral to the soma, the cells of the germ line showing no change. In *Miastor* only whole chromosomes are eliminated, 36 disappearing out of 48 from the somatic line at the third and fourth cleavages in females, and 42 out of the 48 in males[2]. Other Cecidomydæ behave in essentially the same way[3]. There is a possibility that this change in the Cecidomydæ is only one of reducing a polyploid nucleus to a diploid or haploid condition, so being unspecific for members of the basic complement. In *Sciara*, as in the Cecidomydæ, the elimination again differs according to whether the individual will become male or female; but it goes on over a longer period of development, and at least one chromosome, and possibly more, is eliminated in the germ track. In this fly, too, the members of the basic set are differentially eliminated, and genetical evidence shows further that even homologous chromosomes behave differently, those of paternal origin being eliminated while maternal chromosomes remain. One case of elimination is known in plants, supernumerary chromosomes vanishing from the nuclei of what we may call the root line in *Sorghum*, but remaining in at least part of the shoot line, from which, of course, the reproductive cells develop[4].

It thus appears that elimination essentially brings about a difference between the nuclei of germ line and somatic line, the former obviously retaining the full complement of chromosomes, except in *Sciara*, where the loss in the germ line is offset by later and equally remarkable multiplication. In no case is there evidence that the nuclei of the various somatic tissues characteristically have different chromosome complements as a result of further elimination. The precise function of the eliminated chromosomes or chromosome parts is not clear, but in *Ascaris*, and probably in *Sorghum* too, they are heterochromatic[5], and hence presumably lacking in major genes.

Changes of replication are in nearly every case non-specific, all the chromosomes showing the change equally. The chromosomes divide more often than does the nucleus. This leads to polyploid nuclei where the centromeres divide with the chromosomes, and to polytene nuclei, the chromosomes of which have multiple strands as in the salivary glands and other tissues of *Drosophila*, where the centromeres do not divide. The difference between polyploidy and polyteny is thus a minor one from our present point of view, and the two are conveniently pooled under one name. Two such names appear to be in use, and of them endopolyploidy is preferable to polysomaty, for the latter might easily become confused with the term polysomy, which has an entirely different meaning. Sometimes, also, the nucleus may divide without the cell doing so, so giving a third variant, the multinucleate cell or coenocyte[6].

Replication seems commonly to mark the end of active cell division and the onset of differentiation, and White[1] states that the various tissues of insects all have their characteristic degrees of endopolyploidy, some being mosaics of different multiples of the original number of chromosomes. He regards it as likely that the phenomenon is widespread in other animal groups. It is also fairly common in plants, particularly, it would appear, in cortical tissues[7,8]. Here again mosaicism is frequent, and one of its genetical consequences is the production of a proportion of tetraploid shoots among the diploids regenerated from callus originating in the cortex of decapitated tomato stems. The reverse of replication seems also to occur, though less commonly. Apart from the possibility that elimination in the Cecidomydæ is a change of this kind, equal reduction, by what must be tantamount to somatic meiosis, has been recorded in *Culex*[9] and in onion and barley roots, especially in the latter case after treatment with growth substances[8].

We have already noticed that changes of replication are generally non-specific or balanced; but in a few cases replication is confined to specific chromosomes. The so-called *X* doubles itself once oftener than any other chromosome at meiosis in normal male *Sciara*, and the *X* of *Drosophila* does the same when the males are carrying the 'sex-ratio' super-gene. In *Sciara* this behaviour compensates for an elimination early in the germ track, and in sex-ratio *Drosophila* the *Y* is eliminated simultaneously[10]. This relation of specific or unequal replication and elimination may well be significant in animals. It has been claimed that similar replication also occurs in the root tissues of certain orchids where no elimination is known, but the evidence for this behaviour cannot be regarded as final[11].

Changes of manifestation strictly involve no alteration in the number or balance of the genes. A typical example is afforded by the different rates of condensation of the chromosomes in the two daughter nuclei produced by the first division in pollen grains. This difference depends in no way on a genetic inequality between the nuclei, for sometimes by either accident or treatment the spindle is formed 90° out of its true line and then the nuclei condense at equal rates. A cytoplasmic gradient must be the cause of the difference[12]. The difference between two daughter nuclei, one destined to divide again and the other not, at the margin of a meristematic region also marks a change of manifestation, as must many differences of chromosome size and contraction. Some of these changes, such as that concerning future division, must affect the chromosomes equally, but in others heterochromatin and euchromatin may behave differently.

Changes of manifestation, though not themselves involving changes of genic number, may be associated with other changes that do. Thus the daughter nucleus, the fate of which it is to divide no further, may undergo a change of replication. Also the chromosome fragmentation which immediately precedes diminution in *Ascaris* would seem properly to be regarded as a change of manifestation, for of itself it involves no change in the genes (apart from a possible change in position effect), but only a partial breakdown of their linear organisation. It, too, seems to depend on a cytoplasmic gradient like the difference between the pollen grain nuclei[13].

What is the significance of these various changes for our understanding of differentiation? To answer this question we must see that it consists of two parts, and ask not merely what are the effects of the changes, but also what are their causes.

On the various occasions when it has been recorded that nuclear change accompanies differentiation, there has usually been a suggestion, implicit in the presentation rather than explicit in the statement, that the process of differentiation was an effect of the change in the nucleus. This suggested relation is seldom capable of the direct test of experimental breeding, for the differentiated cells and tissues cannot usually be induced each to regenerate an individual organism sufficiently complete for its genetic constitution to be ascertained. Even in plants, where asexual propagation is possible from roots, shoots and even leaves, regeneration is most often from complexes of different tissues. Nevertheless, when all the myriad examples of asexual propagation afforded by everyday horticulture are taken into account, the conclusion seems inescapable that in plants, with the exception of occasional polyploidy, the cells and tissues are genetically alike. Nor can polyploidy, nor any form of endopolyploidy, be regarded as a type of change intrinsically likely to produce differentiation. Polyploidy is one of the most common differences between individuals in plants, and is also known in a number of animals like flies and newts. Apart from the upsets of sexual development predictable from their detailed chromosome constitutions, the polyploid individuals have a normal structure with all the customary tissues developing and co-operating in the customary fashion. Indeed, it often requires a practised eye to distinguish diploid and polyploid by inspection. Whatever their other significance, changes of replication can scarcely be taken as a cause of differentiation.

The case against changes of elimination is a little different. Where they occur, they are commonly associated with a major dichotomy in the fates of the cells, to give soma as opposed to germ line, or root as against shoot. The soma, or the shoot, has, however, itself a host of differentiated tissues associated with no further elimination. Also, as we have seen, elimination is a rare phenomenon, and its counterpart, unequal replication, even rarer. Thus even if elimination (or unequal replication) should in truth cause the differentiation with which it is associated, another and more general cause must still underlie most tissue differences. Furthermore, genetical experience shows that, like polyploidy, monosomy and polysomy in a wide range of plants and animals can characterize whole individuals, all of the tissues of which differentiate and co-operate sufficiently well for viability (though admittedly with rare exceptions all monosomics and polysomics are somewhat abnormal in form and may even be inviable where the genic unbalance is too great). In these species simple elimination could scarcely account for differentiation.

It might, of course, be argued that these observations should be given little weight, that physical elimination or unequal replication as a cause of differentiation is a phenomenon of individual genes rather than of whole chromosomes or of large segments of chromosomes. To do so would be to postulate a process for which there is no independent genetical or cytological evidence. Nor could it give a complete account of the process, for we should still be faced with the problem of why the genes were eliminated or multiplied differentially just at the appropriate times. Indeed, no hypothesis which makes differentiation the outcome of elimination or multiplication, whether balanced or unbalanced, affecting chromosomes, segments or individual genes, can be regarded as satisfactory, for it leaves unexplained the cause of the nuclear change itself. In adopting such a view we should merely replace one genetical problem of differentiation by another. The answer to our question must be sought in another direction, one to which changes of manifestation point the way.

We now have a wide range of evidence to show that the behaviour of a cell depends immediately not on its nucleus, but on its cytoplasm, which, though ultimately determined by an associated nucleus, may be acting in a manner reflecting the nucleus of a past association rather than that of the present. This persistence of the effect of a nucleus in the cytoplasm shows us that the nucleus, though remaining constant in its genetic content, can have a changing effective action. It is constantly acting on and altering the cytoplasm, so that the circumstances in which it finds itself are altering and with them the future effect of its action[13,14].

The nucleus itself affords a sensitive test of the constitution of the cytoplasm, so sensitive that it enables us to detect differentiation within the cell, as we have already seen in pollen grains. Indeed, we have several lines of evidence showing us how the fate of the nucleus depends on the cytoplasm. The timing of nuclear processes in great blocks of tissues, like the spermatogonia of animals, must be brought about through the cytoplasmic connexions of the cells. Pairs of pollen grains with nuclei showing complementary unbalance (5 and 7 chromosomes in place of the normal 6 in *Rhoeo*[15], and 6 and 8 or 5 and 9, etc., in place of the normal 7 in *Uvularia*[16]) can live and their nuclei divide so long as they have cytoplasmic connexions through which the products of locally unbalanced gene action can be evened out; but they die when the cytoplasmic connexion

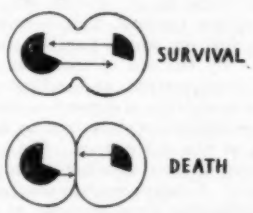


Fig. 1. PAIRS OF POLLEN GRAINS THE NUCLEI OF WHICH SHOW COMPLEMENTARY UNBALANCE, ONE CARRYING IN DUPLICATE THE CHROMOSOMES FOR WHICH THE OTHER IS DEFICIENT, CAN SURVIVE AND THE NUCLEI CONTINUE TO DIVIDE PROVIDED THAT WALL FORMATION IS NOT COMPLETE SO THAT THEY ENJOY A CYTOPLASMIC CONNEXION. WITH COMPLETE WALL FORMATION AND LOSS OF THE CYTOPLASMIC CONNEXION THEY DIE

Fig. 2. POLYMITOSIS OF THE NUCLEI IN MAIZE POLLEN GRAINS DEPENDS ON THE ACTION OF A RECESSIVE GENE IN THE SPOROPHYTE. THE NORMAL OR POLYMITOTIC BEHAVIOUR OF THE POLLEN GRAIN'S NUCLEUS DEPENDS NOT ON THE GENE IT CARRIES, BUT ON THE CYTOPLASM THE POLLEN GRAIN INHERITED FROM ITS PARENT ZYGOTE, WHERE THE CYTOPLASM'S CONSTITUTION WAS DETERMINED BY THE ACTION OF THE DIPLOID NUCLEUS WITH WHICH IT WAS THEN ASSOCIATED

is lost (Fig. 1). Furthermore, the cytoplasm can, in its regulation of nuclear processes, reflect the action of a gene no longer contained in the nucleus. This we can see in Beadle's[17] polymitotic maize, where plants homozygous for the gene produce pollen grains all the nuclei of which undergo premature supernumerary divisions. The chromosomes do not show corresponding divisions, so that the nuclei come to contain reduced numbers of chromosomes, some, in fact, having only one. The result is a group of pseudo pollen grains which all die. Plants heterozygous for the gene must produce two genetically different kinds of pollen, one of which will be like the lethal polymitotic pollen borne on the homozygous plants. But none of this pollen shows polymitotic behaviour. Thus polymitosis is like incompatibility in heterostyled plants[18]. The nuclei of the pollen grains do not determine their own fate. Their behaviour, normal or polymitotic, is determined by the cytoplasm transmitted from the parent zygote, where, however, its constitution was determined by the diploid nucleus with which it was then associated (Fig. 2). This principle even applies to the process of elimination, for the loss of one or two *X*'s, to give females or males, depends in *Sciara* on the genic constitution of the mother, from whom the cytoplasm must have been derived even though the determining gene may not have been passed on to the individual showing the elimination.

Changes of manifestation, which have no direct effect on genic constitution, and so can never of themselves cause differentiation, thus show us how the cytoplasm of one cell can be differentiated so that the fates of the daughter cells will depend, not on which daughter nucleus each obtains (for these will be alike), but on which part of the cytoplasm each inherits. By the aid of these changes we can see how the continuation and adjustment of the processes of nuclear division depend on the cytoplasm, and hence how endopolyploidy can be a response to the condition of the cytoplasm. We can even see how elimination is but another example of cytoplasmic control. Finally, we can see how the cytoplasm, in determining these changes of the nucleus, is itself reflecting the past action of that same nucleus or of some other nucleus with which it has been earlier associated.

All these nuclear changes can be interpreted as responses to an accomplished differentiation of the cytoplasm, and many of them, indeed, demand such an interpretation. The nuclear change is but a consequence of the earlier action of the unchanged nucleus. Differentiation is neither generally nor necessarily dependent on the physical elimination or unequal multiplication of the genes and chromosomes to produce what would be seen in a complete individual as a genetic unbalance; it depends on the physiological reduction or enhancement of gene action by the constitution of a cytoplasm itself reflecting the earlier action of these same genes. The nuclear changes we see are special effects rather than general causes of differentiation. They are special examples of the general process to which all differentiation must be referred.

As an organ the nucleus, like other organs, is part of the phenotype and its behaviour is under the control of its own genes acting in their customary fashion through the cytoplasm. It is true that the phenotypic changes of the nucleus may have a special significance in that some of them might mean changes of the genotype. But this should not blind us to the fact that, even though these secondary changes of genotype may have an adaptive significance in some special cases like *Sciara*, they are nevertheless still secondary. They still depend on a previous change of the nucleus acting as phenotype to the genotype it carried in its earlier and unchanged form. Only if we are careful to distinguish between these two aspects of the nucleus, the recently understood phenotypic as well as the long appreciated genotypic, can we hope to assess the true significance of nuclear change in differentiation.

[1] White, M. J. D., "Animal Cytology and Evolution" (Univ. Press, Cambridge, 1945).
[2] White, M. J. D., *J. Morph.*, **79**, 323 (1946).
[3] White, M. J. D., *J. Morph.*, **80**, 1 (1947).
[4] Janaki-Ammal, E. K., *Nature*, **146**, 839 (1940).
[5] Goldschmidt, R. B., and Lin, T. P., *Science*, **105**, 619 (1947).
[6] Scott, F. M., *Bot. Gaz.*, **99**, 69 (1937).
[7] Lorz, A. P., *Bot. Rev.*, **13**, 597 (1947).
[8] Huskins, C. L., *Nature*, **161**, 80 (1948).
[9] Berger, C. A., Pub. Carnegie Inst., Washington, 496 (1938).
[10] Sturtevant, A. H., and Dobzhansky, Th., *Genetics*, **21**, 473 (1936).
[11] Duncan, R. E., *Amer. J. Bot.*, **32**, 506 (1945).
[12] Darlington, C. D., 38th Annual Report John Innes Hort. Inst., 18 (1948).
[13] Darlington, C. D., and Mather, K., "The Elements of Genetics", Allen and Unwin, London (in the press).
[14] Mather, K., Symposia Soc. Exp. Biol., 2 (in the press).
[15] Darlington, C. D., *Nature*, **140**, 932 (1937).
[16] Barber, H. N., *J. Genet.*, **42**, 223 (1941).
[17] Beadle, G. W., Cornell Agr. Exp. Sta. Memoir, **135**, 1 (1931).
[18] Mather, K., *Nature*, **153**, 392 (1944).

BIOLOGICAL ASPECTS OF WATER POLLUTION

AT a meeting of the Association of Applied Biologists on March 22, five papers were contributed to a symposium on "Biological Aspects of Water Pollution".

Dr. B. A. Southgate, who introduced the subject, said that it includes the treatment of sewage and industrial wastes, the effect of effluents on natural waters to which they might be discharged, and the treatment of polluted water to render it fit for drinking or for other use.

The constituents of domestic sewage are mainly derived from fæces, urine, paper, soap, and vegetable and animal matter. In towns, these are usually augmented by the constituents of gas works liquor,

which contains thiocyanate, phenols, ammonia and sulphide, and of such trade wastes as are associated with industries peculiar to the town. Effluents from manufacturing processes may contain a variety of substances in solution, such as metals or complex cyanides from the metal and electro-plating industries, or plant extracts from such operations as the retting of flax or the washing of vegetables before canning or drying. Colloidal and suspended material is derived from a number of sources, including soil and plant debris.

It is important for several reasons that such wastes should be adequately treated before discharge to surface waters, which are the chief source of domestic water supplies. A high standard of quality is frequently necessary, too, for an industrial water supply, and cases are known in which an industry has had to be moved to a fresh location because the river from which its supply was drawn had become polluted. The purity of rivers is important also to agriculture and to inland fisheries.

In the biological treatment of sewage, purification is effected by interaction of the sewage with the biological film of a percolating filter or with flocs of activated sludge. In both types of treatment bacteria, fungi and protozoa play an essential part, and in the percolating filter the scouring action of worms and fly larvæ is also necessary. Certain types of industrial waste are amenable to separate biological treatment, under anaerobic or aerobic conditions, and some can be so treated that they can be re-used in industrial processes. Inorganic substances such as chromates and cyanides, if present in industrial wastes in appreciable amounts, often have to be removed by chemical means before the effluents are discharged to streams or to sewers.

Dr. L. A. Allen, who dealt with some microbiological problems of the treatment of sewage and trade wastes, said that microscopic examination of the biological film from a percolating filter, or of an activated sludge floc, reveals a mass of bacteria and fungal hyphæ, embedded in gelatinous or mucoid material, together with smaller numbers of protozoa. This material presents to the sewage with which it comes into contact a large and active biological surface which adsorbs a large part of the colloidal and dissolved substances. Microbial metabolism then results partly in oxidation of the adsorbed material and partly in its conversion to fresh cell substance, leading to an increase in the quantity of film or sludge.

Even under most favourable conditions, the effluent discharged to a river from a sewage treatment plant may contain several hundred coliform bacteria per ml. It has been observed, however, that in the course of a few miles natural processes in the river frequently reduce the fæcal organisms to a small fraction of the number discharged. Such an effluent cannot be treated with chlorine to destroy bacteria without first considering the possible effects on the life of aquatic organisms. With some effluents, for example, a dose of chlorine much smaller than the chlorine demand is sufficient to make the liquid highly toxic to fish.

Three examples of trade wastes were chosen to illustrate different types of microbiological problems.

Effluents from dairy premises are particularly liable to cause blocking of percolating filters, the high proportion of carbohydrate resulting in excessive growth of biological film. Investigation has shown that if this film, which consists largely of a tough mat of fungal mycelium, be subjected to starvation, the protoplasm becomes concentrated in certain cells of the mycelium, leaving others empty, thus weakening the mechanical strength of the fungal mat, which quickly disintegrates. In practice, this period of starvation is ensured by employing two filters in series, the effluent from the first filter being fed to the second filter. At suitable intervals the order of the filters is reversed. By this process—now known as alternating double filtration—it is possible to treat certain liquids at three or four times the normal rate.

Disposal of highly polluting waste liquors from the retting of flax has been avoided by subjecting the liquid to continuous aeration during the process of retting. Bacterial oxidation prevents the liquor from becoming acidic and foul-smelling, and reduces the content of organic matter, so that the liquid can be re-used for successive batches of flax.

In the manufacture of beet sugar, the practice of re-circulating the waste waters to diffusers in order to avoid discharging them leads to corrosion in the re-circulation system. Investigation has shown that this is due to formation of acid by thermophilic lactobacilli which can be prevented from growing by applying chlorine to the contents of the battery supply tank or by maintaining the re-circulation system at a sufficiently high temperature.

Mr. T. G. Tomlinson described the percolating filter as an artificial habitat in which both terrestrial and aquatic organisms are found in far greater abundance than in their natural surroundings. The types of fungi which predominate there are largely determined by the character of the liquid being treated. *Saprolegnium*, for example, is encouraged by domestic sewage and by waste waters from processing of food but is inhibited by the trade wastes from large towns; in filters treating the latter, it is usual to find instead two species of *Sepedonium*, characterized by tuberculate chlamydospores, accompanied by *Ascoidea rubescens*, which often produces large ovoid conidia. *Fusarium aqueductum* occupies a rather special place in the surface flora of percolating filters because its holdfast, prostate system of filaments enables it to cling firmly to the medium when washed by the jets of liquid from the distributor.

The population of protozoa shows a gradation throughout the depth of the filter. Polysaprobic zones at the surface contain *Opercularia*, *Paramecium caudatum*, *Colpidium*, and *Glaucoma*. In the mesosaprobic zones lower down are *Aspidisca costata*, *Euplotes*, and testaceous rhizopods; rotifers are found towards the bottom.

Of the Oligochæta, *Lumbricillus lineatus*, a small red worm possessing hæmoglobin, occurs universally in percolating filters throughout the whole year. The handicap of a long generation time and low fecundity is compensated by a low metabolic rate and a strongly gregarious habit.

Among the more numerous insects are two species of *Psychoda*, two of *Spaniotoma*, two of *Metriocnemus*, *Anisopus fenestralis*, *Anisopus collembola*, *Achorutes subviaticus*, and *Tomocerus minor*. The controlling factor in the balance of these species is the amount of film, which in turn depends on the rate at which sewage is applied to the filter. During the warmer months *Psychoda alternata*, with a life-cycle of four weeks at 15° C., and of two weeks at 21° C., is dominant. *Anisopus fenestralis* develops more slowly than *Psychoda*, requiring three months for completion of its life-cycle at 10° C., but its larvæ remain

active at temperatures below 10° C., so that eggs laid in late autumn may give rise to a generation which matures slowly throughout the winter and emerges in the spring.

Dr. Ll. Lloyd, describing the part played by insects and worms in the disintegration of the biological film in a percolating filter, said that whereas in winter surface growth is usually much in evidence and the medium is slimy throughout the depth of the filter, in summer the same medium often appears perfectly clean. In general, depletion in the quantity of biological film has no effect on the efficiency of the filter.

The effect of film depletion is reflected in the behaviour of the flies, and a very good example is afforded by the study of species of *Psychoda* at Leeds. Here the number of *Ps. severini* reaches a peak in May but is small at any other time of the year. *Ps. alternata* shows a peak in June which is followed by a steady decline, and the sequence is then taken up by *Spaniotoma minima*, which builds up an enormous population in the autumn. If the supply of food is sufficient, all three species will breed abundantly from spring to autumn; curtailment of the food supply tends to restrict development, the species which predominates depending on factors which give it a seasonal advantage over its competitors. Introduction of midges (*Metriocnemus* species) introduces a complicating factor. Although essentially grazers on film, they take readily to a predatory habit and when present they tend to restrict the numbers of the three species of flies just mentioned.

There is also some evidence that food supply affects the size of flies. In the absence of other factors, size depends on temperature, wing-length increasing by about 2 per cent for each fall of 1° C. in later larval life. In fact, however, the steady increase due to this factor in the size of flies emerging from August onwards shows periodic interruptions which suggest the effect of shortage of food.

Mr. F. T. K. Pentelow said that the effects of pollution on fisheries may result from damage either to the fish themselves, to their spawn or spawning ground, or to their food. Conclusions from toxicity experiments are complicated by the fact that toxicity is greatly affected by the concentration of such substances as calcium in the diluting water, by the concentration of dissolved oxygen, and by the temperature. An idea of the toxicity of different substances is given by the following figures, which express, in parts per million, the concentrations found to be toxic to trout under average conditions: cyanide, 0·15; sulphide, 1·0; chlorine, 0·2; phenol, 9·0; sulphuric acid, 10·0; *para*-cresol, 6·0; 1.2.6 xylenol, 10·0; the toxicity, to sticklebacks, of copper is about 0·02 and of zinc about 0·3.

The mode of action of poisons varies widely. Cyanide, for example, destroys the enzyme responsible for transferring oxygen from the blood to the tissues, phenols and cresols appear to be nerve poisons, and heavy metals prevent respiration by coagulating the mucus over the body and gills. With some poisons the toxic action is reversible, affected fish recovering after transference to fresh water, but with other substances it is not. Thus, a shoal of fish subjected to the action of phenol from a temporary discharge of gas liquor might easily recover if the current carried them to a zone of cleaner water, but fish affected by discharge of chlorine or ammonia in similar circumstances would die. The behaviour of fish towards a particular substance is no criterion of its toxicity. They will, for example, keep strictly away from waters containing the less toxic zinc salts, but are so indifferent to the presence of the highly toxic copper salts that they are rapidly killed.

Bacterial oxidation of discharged organic matter results in depletion of oxygen in the river water. Though fish may not be actually asphyxiated until the oxygen content falls to between 0·1 and 0·2 part per 100,000, in practice it is frequently found that fish are absent from waters in which pollution has reduced the value to about 0·5 part per 100,000.

The effect of pollution on spawn and spawning grounds is almost unknown territory, but more is known about its effect on fish food. In general, pollution of streams by organic matter frequently results in replacement of the characteristic flora and fauna by other types, but without necessarily reducing the total quantity of material acceptable to fish as food. Pollution by inorganic substances is a very different matter. For example, discharge of copper wastes to a stream has been known to render it unable to support the life of trout, even in zones downstream where the concentration of copper is much too small to be directly toxic; this is because the copper has destroyed the animal life on which carnivorous fish like trout depend.

THE ROYAL ACADEMY, 1948

By Dr. A. TINDELL HOPWOOD
British Museum (Natural History)

SOCRATES once likened books to pictures because, "the creatures of the latter art stand before you as if they were alive, but if you ask them a question, they look very solemn and say not a word". To an argumentative old man the lack of response was deplorable; but to the pictures themselves, had they been sentient, it would assuredly have been the height of wisdom. Many a canvas would be covered with confusion, and mantled with blushes, were it suddenly to be faced by Socrates and to hear the dread question, "Why were you painted?" Imagine the unease of the self-confessed pot-boiler, the tearful admission of the failures, and the venomous hatred of the shams. No, it is just as well that pictures cannot reply in words. On the other hand, our questions are not left entirely unanswered; but some degree of skill is needed to decipher the very solemn faces masking the replies.

Now, morally there is nothing wrong with an honest pot-boiler. A certain snobbish section of the public is only too ready to repeat hollow phrases about 'art for art's sake', without pausing to reflect that artists, like other men, must eat. Provided that the painter of a pot-boiler has the pride proper to a good craftsman, he plays a useful part in life, even though he does not produce a masterpiece. After all, and we may just as well admit it, none of the great masters of the past, not even Rembrandt or Turner, was consistently inspired; many a picture to which a famous name is attached is to be valued for its craftsmanship rather than for its genius. So let us praise honest craftsmanship wherever we find it, rather than indulge in unkind sneers at the unfortunate whose inspiration has forsaken him for a while.

Failures and shams are another matter; each reflects upon the character of its author. The failure exposed to public view argues a lack of that sensitivity which is necessary for the recognition that success has eluded one's efforts. As for the painters of shams, it can only be hoped that their spirits may meet with Socrates in the shades: that were punishment infinitely worse than the torment reserved by Dante for the hypocrites.

Why all this? Well, it's a dull Academy this year, and I do not like dull academies. Good ones are exhilarating, bad ones can be interesting; but dull ones are just dull. Perhaps the hanging is not quite up to standard, and the hanging can make or mar an exhibition. Indeed, the skill and knowledge needed to hang a single wall well, let alone a whole room, seldom receive the recognition which is their due. As a rule, visitors are so busy with the details that they spare no thought for the whole. On the other hand, every experienced gallery-goer has memories, either of good pictures spoiled by bad hanging, or of mediocre pictures vastly improved by good hanging.

Some may remember a certain north wall in one of the Academy's own rooms that was a masterpiece of the hanger's skill a few years ago; two pictures, which normally would have been pushed into a quiet corner, were put in the very centre of the wall, and their sophisticated crudity of colour allowed to lose itself among pictures of an entirely different type and key. The arrangement of that wall revealed the touch of a master; but this year it seems that some of the best pictures are overshadowed, perhaps outshone would be the better word, by the stronger colour of less meritorious neighbours.

The first thing to strike the eye as one ascends the staircase is a curious, whitish, skeletonized structure dominating the Central Hall; actually it is a ferro-concrete version of Bellerophon astride Pegasus, but it also serves to suggest that we begin with the sculpture for a change. Two portraits are of particular interest. One is "Sir Alexander Fleming, F.R.S.", by E. Roland Bevan, and the other "The Viscount Nuffield", by Maurice Lambert. This latter is remarkable for the skill with which the problem of combining originality of treatment with the conventions of formal statuary has been solved; as proof of the sculptor's versatility there is "Starbird" in the South Room. The Lecture Room contains many pleasant pieces; among them are several good figures of animals. "Hunting Leopard" and "Cheetah", both by Pamela Ascherson, "Friesian Bull" and "Complacent Cat", by Marjorie Drawbell, "Cat" by Richard Garbe, and "Falcon" by John M. Luxmore, are only a random selection.

The Lecture Room leads into Gallery IX, the black-and-white room, which contains four drawings of antelopes by Frank Dobson, those of the "Kenya Impala" and the "Black Buck" being particularly good. Barbara Greg's pen and wash drawing of "Adelaide Crescent, Hove", which hangs a few feet away, deserves a better place than it occupies at present. Her woodcut, "A Meeting of the Hell-fire Club", is less successful.

As a rule the Architectural Room contains smaller pictures by lesser lights; but this year there is an imposing array of academicians to keep them company and to spur them on to greater efforts. Here hang "The Blue Sitting Room, Trent Park" by Winston S. Churchill, and "Herrings and Lobster" by Edward le Bas, as well as "Kippers" by Robert H. Hurdle—a newcomer, I think—whose "Round Table: Still Life" in Gallery IV is one of the best pictures of its type in the exhibition.

Of the younger artists, as I judge them to be, Lionel Miskin (No. 30) and Kenneth Martin (No. 42) seemed to be the best in the first room, and Ernest Sandoe (No. 35) is better this year than last. In Gallery II "The Interval", by Jean Primrose, more than maintains the high level of her pictures last year; "Bannockburn", by Colum Gore-Booth, also deserves a word of praise.

Gallery III is, of course, the main room, and one does not expect many beginners to grace its walls; but two pictures by less well-known painters ought to attract favourable attention; they are "A Present from Provence", by Enid Solomon, and "The Bay", by Adrian Hill. Mr. Churchill's "Blenheim Tapestries" is not so satisfying as his "Goldfish Pool, Chartwell", in the previous room. In portraiture, Henry M. Carr vies with Sir Gerald Kelly, pitting his "F.-M. The Viscount Alexander of Tunis" against the latter's "Sir Malcolm Sargent": one feels that each was completely absorbed in his sitter.

Among paintings in other rooms are "The Fiddler", by Violeta Janes, and "Copying at the National Gallery", by Douglas Mays, both in Gallery V. Apparently this is the first time Miss Janes has exhibited, whereas Mr. Mays, who is 'on the line', made his first appearance last year.

The water-colours, in the South Rooms, are an attractive and varied display. Vivian Pitchforth and John Nash are a continuing inspiration to many, though few come anywhere near them in execution or content. Of the others, I particularly liked "Suffolk Landscape", by Rowland Suddaby, Dorothea Maclagan's flower pieces, "Haze Lifting, Newhaven", by Hadley Rowe, "Propeller Stacks, Deptford Creek", by Innes Meo, and "Cotswold Landscape", by Elizabeth Sorrell.

OBITUARIES

Dr. H. W. Richmond, F.R.S.

Herbert William Richmond, the eminent geometer, died of heart failure in the Evelyn Nursing Home, Cambridge, on April 22, at the age of eighty-four. At the time of his death he was senior fellow of King's College, Cambridge, where he had resided almost continuously for sixty-five years. The only substantial break in this long period of residence was during the First World War, from 1916 until 1919, when he worked at ballistics at Portsmouth with A. V. Hill and the late Sir Ralph Fowler; during this period he helped to make important contributions on the effects of winds on high-angle trajectories and the effects of spin on the motion of a shell. The last-mentioned work was done in conjunction with R. H. Fowler, E. G. Gallop and C. N. H. Lock; it was published in the *Philosophical Transactions of the Royal Society*, and afterwards became a classic. After the War he edited at Cambridge the confidential "Text-Book of Anti-Aircraft Gunnery", Vols. 1 and 2.

Richmond was born on July 17, 1863, at Tottenham (Middlesex), at Draper's College, of which his father, the Rev. Wm. Hall Richmond, was headmaster. He was educated at Merchant Taylors' School (1875–82), and went up to King's College, Cambridge, in 1882

with an Eton scholarship thrown open on this occasion. In 1885 he was Third Wrangler in Parts 1 and 2 of the Mathematical Tripos, and he was placed in Division I of Part 3 of the same Tripos six months later. He was elected a fellow of King's in 1888, and remained a fellow for the rest of his life. He was lecturer in mathematics at King's from 1891 until 1927, and University lecturer at Cambridge during 1901–19 and again during 1926–28. He was elected a fellow of the Royal Society in 1911. He was president of the London Mathematical Society for 1920–22, and he received the honorary degree of LL.D. from St. Andrews in 1923.

Richmond's mathematical interests lay chiefly in the fields of pure and algebraic geometry. He has left it on record that the side of geometry that appealed to him and fascinated him, in his undergraduate days and later, was the algebraic geometry of Steiner, Hesse, Cayley and Salmon—the geometry of cubic and quartic curves and surfaces worked out by methods of elementary algebra. This (he went on) was not exhausted, but was largely worked out, as he discovered when he went on to research, although a new field of research was opened up in geometry of four dimensions. Richmond's skill lay in the discovery of relations between apparently dissimilar groups of theorems, and his papers achieved much with notable economy of effort. He never failed to be interested in chains of theorems in plane geometry; but he also took pleasure in deducing theorems in the theory of numbers by geometrical methods. He was wont to consider the modern pure mathematician's restriction of interest to the *positive* integers as artificial and as reducing the geometrical implications of such theorems as Waring's. He continued his output of original work up to shortly before his death.

Richmond had a deep love for music—he devoted himself to this for a period after taking his degree. He also took a keen delight in all living creatures, and he was no mean naturalist. In his earlier days he went regularly to the Orkneys and Shetlands to photograph sea-birds and their nests. He had served on the Committee for Wicken Fen. But no bare record of his interests and achievements can do justice to the true qualities of the man. He had a rare genius for friendships with men of all generations, and in spite of his shyness he made a point of being helpful to men who came up from the lesser known schools without friends or influence. His modesty was terrific—that adjective alone fits. One recalls also his engaging humour, his humanity and his impatience with anything pretentious or shoddy. It was lovely to know him. His death robs Cambridge of a retiring but much-loved character.

E. A. Milne

Prof. P. A. C. Dangeard

Pierre Augustin Clement Dangeard was born at Ségrie-Vernie (Sarthe) on November 23, 1862. The son of a peasant stock, from which he doubtless inherited his individualism and determination, he entered l'Ecole Normale Primaire d'Alençon in 1878, becoming a school-teacher three years later. In 1883, his botanical aptitude having attracted the attention of Morière, then professor of botany at Caen, he was appointed demonstrator there, and lecturer in 1886. He moved to Poitiers in 1891, and was promoted professor in 1894. In 1908 he left Poitiers for Paris, where, in 1924, he succeeded G. Bonnier in the chair of general botany at the Sorbonne. He retired to the family property at Ségrie in 1944, and, after two years of troublesome illness, died there on November 10, 1947.

Dangeard was elected to the Academie des Sciences, Paris, in 1917. In 1931 the University of Cambridge conferred the honorary doctorate of science on him (family illness had prevented him from attending the Fifth Botanical Congress in 1930). The Linnean Society of London elected him a foreign member in 1935. Dangeard was awarded his doctorate by the Faculté des Sciences, Paris, for his "Recherches sur les organismes inférieurs" (1886), a contribution to botany which brought him the support of the algologist Bornet, and the Prix Desmazières (1887), and which laid down the main lines of many of the investigations which occupied him for the rest of his life. Developments and extensions brought further important publications (1896, 1903, 1904), on the cytology and sexuality of the fungi; these were recognized by the Grand Prix des Sciences Physiques de l'Institut de France. These contributions not only extended his own work, but they later generated a great volume of research by numerous workers all over the world on subjects which still claim the active attention of a number of botanists. Dangeard's demonstration of the nuclear fusions in young asci and basidia stands as a solid addition to our knowledge, though perhaps because investigations by other workers in the same field may have been over-valued, especially outside France, recognition was slow in coming to him.

In 1887 Dangeard began to issue *Le Botaniste*, a periodical supported from his own resources, which eventually ran to thirty-one volumes of some three hundred pages each, very many written by Dangeard himself. In the first issue, he explained that he had founded *Le Botaniste* so that he might have a means of publication which was wholly under his own control, in which he could express freely and defend adequately his own ideas, and in which he could assail freely any views which he deemed to be faulty. This explanation, and the contents of the periodical, illustrate the character of the man. He was extremely independent in his outlook, a tireless and accomplished observer, and a bold expositor of wide generalizations. With all that, and with a periodical completely his own, he was a fair controversialist. Throughout his life, Dangeard was greatly interested in those organisms which lie on the boundary between the plant and animal kingdoms, and in their relatives. He described a great number of new genera and species, he made detailed studies on the structure and physiology of the cell, and he put out a very clear exposition of the nature of sex, stripping that much-debated matter of morphological complications. At times, his wide outlook and his genius for broad generalizations may have put his conclusions in advance of his evidence, but his conclusions were certainly not sterile, for they led to renewed research. As we always expect from a Frenchman, his writings are clear and brilliantly luminous, so easy to read that a careless reader is in danger of missing a great deal that lies in the background.

P. A. C. Dangeard has left, in *Le Botaniste* and elsewhere, a noble record of a long life of active devotion to his subject. May that record stimulate those now working in his field, for the lower organisms and the cell have not yet yielded all their secrets.

B. Barnes

NEWS and VIEWS

Study of Public Administration

In his inaugural lecture from the new chair of public administration at the London School of Economics and Political Science on February 3, 1948, Dr. W. A. Robson welcomed the creation of the chair as a sign of the extended recognition now accorded to the study of public administration by the University of London (London: Stevens and Sons, Ltd. Pp. v+26. 2*s.* 6*d.*). It is impossible, however, for this vast field to be covered adequately in regard either to teaching or research, he said, unless far greater provision is made for senior posts at academic institutions throughout Britain. The expansion in the scale and scope of public administration is a dominant feature of our times and is to be seen not only in the growth and multiplication of government institutions and of the public corporations, but also in the new conception of the task of government. The keynote of most of the recent developments has been extreme centralization, and Dr. Robson expressed the view that contemporary trends are not in conformity with the best democratic principles and that we are not making the most efficient use of our resources of political energy, administrative ability and experience. In particular, he criticized the failure to appreciate the need for a democratic form of regional government, and supported the view advanced since in the second report of the Local Government Boundary Commission that the Commission should be given wider powers. Public ownership and the nationalization of industry both call for much greater efforts to measure the results of public administration in relation to its cost in terms of money and effort, and he believes that the question of centralization and decentralization needs discussion in the universities before a coherent body of principle is likely to be evolved for practical use.

At the Cabinet-level also, there are changes which call for further study and discussion, and such problems as questions of personnel administration, the distribution of powers, methods of control, organic relationships and constitutional development require re-examination, quite apart from the new problems presented by nationalized industries and the relations between public corporations and Parliament. He urged that the Economic Survey should be accompanied by a corresponding survey of public administration at intervals of not less than a year. Overshadowing all is the problem of how to ensure that the vast powers which are needed by the executive are conferred and exercised in conformity with the political traditions and the liberal spirit of the British people. He urged that we should cease to think of freedom only in terms of the absence of restraint and consider it also in terms of opportunity. He suggested that Parliament should take pains to define more carefully the executive powers which it confers; to state more clearly the purposes for which they are to be used; and to see not only that the rights of the public and the duties of public authorities are reciprocal, but also that the obligations of the citizen and the executive are mutual. Finally, he pleaded that the universities of Britain have a special contribution to make to the discussion of such problems, by diffusing a knowledge of the principles underlying a sound system of democratic government among the wide range of students, by helping the community to become more discriminating in its attitude to government, more critical of defects and more appreciative of achievements in the public service, and by investigating the working of institutions and analysing policies and processes. The more closely the different branches of social science can co-operate in a combined attack on the complex problems confronting us, the more effective the result is likely to be.

Annular Eclipse of May 8–9

Bad weather conditions went far to spoil the project of the National Geographic Society to link up the triangulations of Asia and of the United States and Canada by exact timing of contacts at the recent eclipse (*Nature*, March 13, p. 389). Only two expeditions—those to Rebun Jima, a little fisher-folk island off the north-western tip of Japan and to Bangkok in Siam—were favoured by clear enough conditions to get satisfactory results. Dr. C. H. Smiley, head of the last-named party, reported thin cirrus clouds, while Dr. John A. O'Keefe of the other party had ideal conditions due to a last-moment clearing. These two observations may link up the Indian geodetic triangulation with those of Japan and possibly Korea. A link-up with the American triangulation may also be possible owing to the successful photographs secured from two *B*29 Superfortress planes working from an air base on Shemya Island in the Aleutians. Short-range navigation methods were used, radar signals being sent out from the aeroplanes and received by ground stations the exact locations of which were known. Obviously fresh problems are involved in the use of data from moving aeroplanes, and it will be interesting to see the final reports when the material obtained has been examined. It is to be hoped that Great Britain, from which the suggestion first originated that eclipse observations might be used for geodetic studies, may before long take a part in securing some valuable results along these lines.

Hylean Amazon Institute

A nine-nation Conference for the creation of an International Institute of the Hylean Amazon, called jointly by the Governments of Peru and Brazil and by Unesco, has successfully concluded its deliberation at Iquitos, Peru. A convention establishing the Institute was agreed upon and will come into force upon final acceptance by the founding nations. The following nations signed the final act of the Conference: Bolivia, Brazil, Colombia, Ecuador, France, Holland, Italy, Peru and Venezuela. The scientific programme for the Institute was formulated, and a budget of approximately 300,000 dollars was set for the first year of the Institute's operation. A financial protocol was also signed by Bolivia, Brazil, Colombia, Ecuador, France, Holland, Peru and Venezuela, which determined the scale of national contributions toward financing the Institute. The United States and the United Kingdom expressed great interest in the Institute, and will study ways of actively participating in its work.

Pending the initiation of the operation of the Institute, an Interim Commission was established and the first meeting of the Commission opened in Manaos, Brazil, on May 13. In accordance with instructions from the Unesco General Conference held in Mexico last year, the Director-General has obtained the services of outstanding world experts to carry out surveys in anthropology, biology and soil science to guide the investigators of the Institute during its first years of operation in the Hylean

Amazon region. A survey will also be made of the existing scientific knowledge of the region and of the work carried out by institutions in other parts of the world on man's relation to a tropical environment.

The Wool Industries Research Association

THE report of the Director of Research for the Wool Industries Research Association for 1947–48 summarizes a five-year building plan to provide permanent buildings for plant and workshops on the lower half of the Torridon plot. Construction of a new physics block, with provision for workshops and drawing offices and a central steam-raising plant for heating and process is already in progress, and together with a new woollen block is to be completed in 1948. The provision of a new wing for a library, offices and canteen is postponed until conditions become easier. As a result of a conference of eight research associations, a standing conference is to be constituted and the exchange and study of programmes of textile research is to be commenced immediately. A survey of shortened drawing processes in members' mills has emphasized the attention which must be given to yarn characteristics when considering a reduction in the number of drawing processes; other surveys lending themselves to detailed statistical analysis have covered the occurrence of slubs and faults in yarns and the scouring and milling of woollen and worsted pieces. Progress is also reported in the measurement of the characteristics of a yarn as they affect its ultimate performance, high-draft spinning and the mathematical and experimental study of the drafting process.

Fundamental investigations noted in the report include the confirmation and extension of the theory of water absorption by wool, the diffusion of formic acid and of large molecules in keratin, the behaviour of ions in horn keratin and a physico-chemical study of the washing of raw wool. Evidence was obtained that the molecular arrangement of the amino-acid residues of which the keratin molecule is composed is much more complex than was entertained in current theories. A new method of breaking down wool to macro-molecular components apparently similar to those obtained by Mercer by the use of enzymes has yielded extremely interesting results, and investigations of peroxide bleaching have continued, as well as biochemical work on the naturally occurring polypeptides, gramicidin *S* and tyrocidine. Analysis of the peptides derived from wool containing the dicarboxylic acids and of the peptides containing cystine has continued. Biological research has included fleece studies of the Romney flock maintained at Cambridge as well as follicle studies; while in the technological field, in addition to completing a detailed examination of the resistance to washing of proprietary moth-proofing agents, the Association has suggested to the Society of Dyers and Colourists the establishment of a committee to investigate the standardization of larval testing and of washing processes appropriate for assessing moth-proofing agents. Laboratory work on combing oils, woollen oils and fastness tests has continued, as well as studies of speciality fabrics, mechanical properties of yarn and cloth, and the performance of rapid regain measurement machines on the market.

The British Boot, Shoe and Allied Trades Research Association

THE first annual report of the Council of the British Boot, Shoe and Allied Trades Research Association covers the year ended December 31, 1947. The new Council, elected in June 1947, consists of members elected on a regional basis, together with co-opted members; the Scientific, the Industrial and the Statistics Committees supervise, respectively, the work of the Scientific and Technical Division, the Industrial and Productivity Division and the Trade Statistics and Economic Research Division. The chairmen of these three Committees are also members of the Finance Committee which controls the work of the Information and Administration Division. Of the 973 consulting questions recorded during the year, 45 per cent related to wear complaints, chiefly perspiration and damage by heat. Reports are in preparation on service trials of boots containing test components, tests of a co-polymer of vinyl acetate and vinyl chloride as a lining fabric, the use of 'Mycocide L' under factory conditions, the deformation of various shoe materials, a survey of children's feet and an analysis of American Army foot measurements. An interim report on the performance and quality of welt-sewing needles has been published, and work on the water-proofness testing machine is almost complete. Experiments on the use of a Baldwin moisture meter modified for use with leather have been completed, and practical applications are being investigated. A small laboratory has been set aside for testing adhesives, and work on the effects of perspiration on upper and insole leather has continued. The Council has also endowed a Satra Research Fellowship at University College, London, tenable for two years in the first instance, for research on the structure of the human foot and on the mechanics of human locomotion, and the first fellow, Dr. R. H. Hardy, commenced his duties on January 1, 1948.

The Society for Psychical Research

IN a recently published pamphlet entitled "The Society for Psychical Research: an Outline of its History" (London, 1948. 2*s*.), which has been issued by the Society and written by its president, Mr. W. H. Salter, the author has provided a very useful account of the Society's activities from its foundation in 1882 until the present day. It is not generally realized what an immense amount of work has been done by members of the Society, a fact illustrated by its forty-eight volumes of *Proceedings*. Although the quality of the material presented is by no means uniform, the standard set by the more cautious members of the Society has always been a high one in spite of the persistent and sometimes successful attempts of its more emotional adherents to minimize the paramount importance of sound evidential material, and to introduce papers which tend to discredit the work of the Society both at home and abroad.

In his admirably objective account of the Society, the president has passed in review the various stages of its eventful career, although the general reader would scarcely realize from the author's smooth-running narrative that the two schools of thought mentioned above were always present within the Society, and that both are to this day still striving for mastery. It is these wide differences of opinion that make the Society so unlike the majority of scientific societies. For on one side we have those who believe that the Society's main function is to preserve the highest scientific standards both in research and publication, whereas on the other are grouped those who would make the Society a kind of academic and dignified spiritualist body voicing

the views of those who find in popular spiritualism a system of thought and practice too crude to attract the more educated believer. As a well-balanced and judicious survey of the Society for Psychical Research past and present, this little book is to be highly commended. It shows the Society in what may be thought by some to be its best role, namely, a nucleus around which are gathered research workers of varied opinions who can use its platform for their results and get expert help and guidance when required for improving the quality of their work and assessing its value. The Society has had a long and distinguished career, and much of its published material is of the greatest value both to the psychologist and to the student of evidence and the value of testimony. To those who wish to inform themselves more fully of these aspects of the Society's work, no better introduction could have been devised than this little book.

Learning and Industry

A VALUABLE means of bringing about active co-operation between industry and the universities has recently been shown by the United Steel Companies, Ltd. At the invitation of the chairman, Sir Walter Benton Jones, fourteen mechanical and production engineering professors from British universities spent four days, beginning on April 12, in visiting the branches of the United Steel Companies at Sheffield, Scunthorpe and Stocksbridge, and in joint discussion both at the various works and at the Sheffield headquarters. Among the topics discussed were the design of Siemens open-hearth furnaces, the fuel balance of an integrated steelworks, and, led by Sir Charles Goodeve, director of the British Iron and Steel Research Association, some general research problems of the iron and steel industry. It was clear from the discussions that the research staff of the United Steel Companies were grateful for suggestions thrown out by the professors, while the latter were appreciative of the new problems put to them and which, in some cases, could usefully be followed up by them and their research staffs. By arranging this tour the United Steel Companies have shown a way in which industry and scholarship can work together for their mutual help and the well-being of British economy.

Australia and New Zealand Association for the Advancement of Science

THE report of the twenty-fifth meeting of the Australia and New Zealand Association for the Advancement of Science, held at Adelaide during August 1946, with its list of officers and research committees, balance sheet, constitution and by-laws, sectional transactions and reports of research committees, is something more than a useful reference work for the Association. In addition to Dr. P. Marshall's presidential address on "The Permanent Pacific" and Dr. Adrien Albert's Liversidge Centenary Lecture on "What can Chemistry Contribute to the Mastery of Disease?", it includes the addresses of the sectional presidents. Some of the latter, such as those of Dr. Ian W. Wark to the Chemistry Section on "Australian Research on the Theory of Flotation", Dr. W. M. Bryan on "The Geological Approach to the Study of Soils", Dr. J. Pearson on "Some Problems of Marsupial Phylogeny", Dr. R. Wilson on "Facts and Fancies of Productivity", Dr. H. W. Bennetts on "The Pathological Approach to Problems of Animal Disease", and Prof. E. Ashby's "Survey of Botany in the Soviet Union" appear to be of notable scientific interest and deserve the wider audience that they can now reach. Among other addresses included are those of R. Lemberg on "New Aspects of the Theory of Function of Respiratory (Hæmatin) Enzymes", A. Gottschalk on "Some Aspects of the Relationship between Chemical Structure and Enzyme Specificity", and of A. T. S. Sissons on "The Widening Front of Pharmaceutical Science".

Archæology in South Africa

THE report for 1946–47 of the Archæological Survey of the Union of South Africa has been published (Johannesburg). The most interesting piece of information therein is that the Little Caledon River has apparently cut its bed down some 300 ft. through Beaufort Sandstone since the occupation of the upper part of the valley by early Stellenbosch man. Sandstone, of course, is not such a hard material as basalt; nevertheless, a long period of time must be postulated since early man lived in those regions. Dr. van Riet Lowe has published a note in the *South African Archæological Bulletin*, **2**, Pt. 8 (1947) on some interesting tanged and winged arrow-heads. This type of tool has not been found heretofore in the Union. Dr. van Riet Lowe assigns them, no doubt rightly, to a Neolithic stage of development. He does mention, incidentally, the discovery of somewhat similar arrow-heads in a so-called Solutrean *milieu* in eastern Spain; but it may be premature to assign Dr. Pericot's finds definitely to the European Solutrean culture. Spanish prehistory south of the northern mountain ranges looks mainly to North Africa for its connexions. Maybe the word Aterian will have to be substituted for Solutrean eventually. But the occurrence of tanged and winged arrow-heads in the South African Neolithic is indeed an interesting addition to knowledge.

Identification of Important Indian Timbers

IF any one factor could be picked out as justifying forestry research in the tropical and sub-tropical forest containing many timber species growing in mixture, it would consist in some popular means of identifying the various kinds. This problem first presented itself in India during the First World War, when many species of timber, practically previously unmarketable, came into use. The demand on the Indian forests was far greater in the Second World War. For the use of the Army, six leaflets entitled "How to Identify Timbers" were issued from Dehra Dun. These have now been collected together into *Indian Forest Record* (Utilisation), Vol. 3, No. 7, by the wood technologist of the Forest Research Institute, and keys and photomicrographs of the timbers that are commercially available in the different military zones of inspection have been added. The photomicrographs, on which 114 timbers are shown in 57 plates, are very clear. The writer says they will be as useful to the commercial trader as to the military authorities; he might have added also to the district forest officer and his staff in parts of the country where new timbers, previously unmarketable, are now commercially salable.

The Food of Humming-Birds

AN excellent monograph on the feeding and related behaviour of humming-birds (with special reference to the black-chin, *Archilocus alexandri*) was prepared by Frank Bené before his death in 1943

and has now been published as a Memoir of the Boston Society of Natural History (**9**, No. 3; October 1946). The work was carried out during 1939–42 in Phœnix and other localities of Arizona, and, because of its docility, its fondness for commercial sweets, and its regularity in returning to feed from artificial sources of food, the humming-bird proved to be an amenable subject for observation and experiment. The black-chinned humming-bird is strongly migratory, and its arrival on the spring breeding ground coincides with the flowering of its food plants. The sexes select and maintain isolated territories and meet on a neutral ground, the lex. Feeding habits of the humming-bird support Howard's theory of the nutritive function of territory. The monograph also describes the feeding routine, type and quantity of food consumed and the three feeding techniques—flower-probing, hovering-pecking and fly-catching. The Memoir contains twelve black-and-white plates which should delight all bird lovers.

The Brotherton Collection, Leeds

THE eleventh and twelfth reports of the Brotherton Collection Committee, University of Leeds, covering the sessions 1945–46 and 1946–47, respectively, estimate the contents of the Collection on June 30, 1947, as 22,700 books, 15,413 pamphlets, 473 manuscripts, 4,105 deeds, 31,158 letters and 25 maps; the increase on June 30, 1946, being 61 books, 65 pamphlets and 32 letters. Undergraduates continued to use the Collection for special studies, particularly in English literature, and the return to more normal conditions was shown by an increasing number of inquiries from abroad. Many of the visits to the Collection during 1945–46 were specially arranged in connexion with an exhibition of the collection of English county atlases and road maps presented to the University by Dr. Harold Whitaker. The practice of holding exhibitions of the Collection's treasures is to be revived, and during 1946–47 an exhibition of bindings was arranged in connexion with the Leeds Conference of the International Society of Leather Trades Chemists. The re-cataloguing of books in the English literature section continued and 2,601 slips were added to the Supplementary Catalogue in 1945–46 and 880 in 1946–47. Ten books and pamphlets were presented in 1945–46 and 101 purchased, the corresponding figures in 1946–47 being 74 and 52 as well as 52 autograph letters presented.

Linnean Society of London: Anniversary Meeting

AT the anniversary meeting of the Linnean Society of London held on May 24, the Linnean Gold Medal was presented to Dr. Agnes Arber, and Trail Awards and Medals were presented to Dr. Honor Bridget Fell and Dr. Cyril Dean Darlington. The following were elected officers for the session 1948–49: *President:* Prof. G. R. de Beer; *Treasurer:* Colonel F. C. Stern; *Secretaries:* Dr. B. Barnes (Botany), Dr. A. Tindell Hopwood (Zoology). The new members of council were Mr. James M. Fisher, Mr. N. B. Kinnear, Prof. W. H. Pearsall, Dr. W. R. Philipson and Mr. N. Y. Sandwith.

South Eastern Union of Scientific Societies

THE fifty-second annual congress of the South-Eastern Union of Scientific Societies will be held at Great Yarmouth during June 14–19, under the presidency of Mrs. Jacquetta Hawkes, who will speak on "Archæology and the Present". The meetings will be held in the Town Hall. The sectional presidents and the titles of their addresses are: H. J. Howard (Botanical Section), "The Mycetozoa of Sand-dunes and Marshland"; Lieut.-Colonel S. E. Glendenning (Archæological Section), "Local Materials and Craftsmanship in Norfolk Buildings"; C. D. Ovey (Geological Section), "Foraminifera in Stratigraphy with Special Reference to the Ecology of Living Forms"; Major Maxwell Knight (Zoological Section), "The Study of Bird Pellets as a Subject of Interest and Instruction to Amateur Naturalists". On June 17 there will be a "Young Naturalists' Evening", at which Nature films will be shown and a 'brains trust' held. A discussion on the functions and organisation of local societies, to be opened by G. E. W. Gosnell, will be held on June 18. The local secretary of the meeting is Mr. P. E. Rumbelow, 27 Rodney Road, Great Yarmouth; the honorary general secretary of the Union is Mr. F. J. Epps, 78 Dunwich Road, Bexleyheath, Kent.

Population and World Resources in Relation to the Family

AN International Congress on "Population and World Resources in Relation to the Family" will be held at Cheltenham during August 23–28. The programme for the Congress, which has been organised by the Family Planning Association of Great Britain, includes general sessions devoted to the following topics: world resources; essential standards of living; migration as a factor in the adjustment of national populations; sociological implications of family limitation in various typical countries; birth control as a factor in the adjustment of national population; ethical and medical advantages of planned family limitation; current and future research in problems of fertility, infertility, sex and marriage; agencies for the dissemination of knowledge and propaganda. Further particulars can be obtained from the Cheltenham Congress Organiser, 37 Park Street, London, W.1.

Announcements

SIR JAMES CHADWICK, honorary fellow of Gonville and Caius College, Cambridge, and Lyon Jones professor of physics in the University of Liverpool, has been pre-elected Master of the College to succeed Mr. J. F. Cameron, who retires on September 30.

THE Association of British Science Writers is holding its first forum discussion meeting on "Science and the Press" on June 9 at 7.30 p.m. at the Society for Visiting Scientists, 5 Old Burlington Street, London, W.1. The meeting will be open to the public and admission is free.

A RESEARCH scholarship of the value of £400 per annum and tenable for two years has been offered by the Aluminium Development Association to encourage and facilitate research in the application of light alloys to ship construction. The scholarship will be administered by a Committee of the Institution of Naval Architects and it is hoped to make the award in September. Full particulars of entry, which closes on July 31, can be obtained from the Secretary, Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1.

ERRATUM. In the communication entitled "Transmission of Bactericidal Radiation through Glass" (*Nature*, May 29, p. 856), the lettering of the two curves should be interchanged.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Meson Scattering with Nuclear Excitation

In examining a number of Ilford *C*2 plates, loaded with boron, and exposed to cosmic rays in aeroplanes at an average altitude of 8,000 ft. for about 72 hours, we have come across an interesting track which is reproduced herewith. The track starts at one surface of the emulsion, extends for a length of about 470 μ and then suffers a sharp bend through an angle of 29° at the point *b*. It thereafter continues for a distance of 134·4 $\pm$ 0·5 μ and ends in the emulsion.

For a number of other tracks in the same plate which end in the emulsion, the total number of grains N has been counted as a function of the residual range R, and $\log_{10} N$ then plotted as a function of $\log_{10} R$. In this way we obtain a figure similar to Fig. 4 of the article by Lattes, Powell and Occhialini[1]. The tracks fall into two clearly differentiated groups, one of which can be identified as due to protons, the other as due to mesons. Now counting the number of grains as a function of the residual range for the track *eb* yields points lying *within* the set of points obtained for mesons, and on the side of higher rather than lower grain density. This allows one to identify the track unambiguously as due to a meson which comes to rest in the emulsion, though we cannot, of course, say whether it is a π-meson or a μ-meson. The grain density just after the bend is 0·76 grains/μ, which is in good agreement with that to be expected from our curves for the observed residual range of 134·4 μ. Coming now to the part of the track *ba* before the bend, we have counted the number of grains along it for every ten scale divisions of track, up to a total length of 420 μ, starting from the point *b*. The last 50 μ of track is too near the surface of the plate to allow accurate grain counts, and this portion has therefore been omitted. The result is given in Table 1.

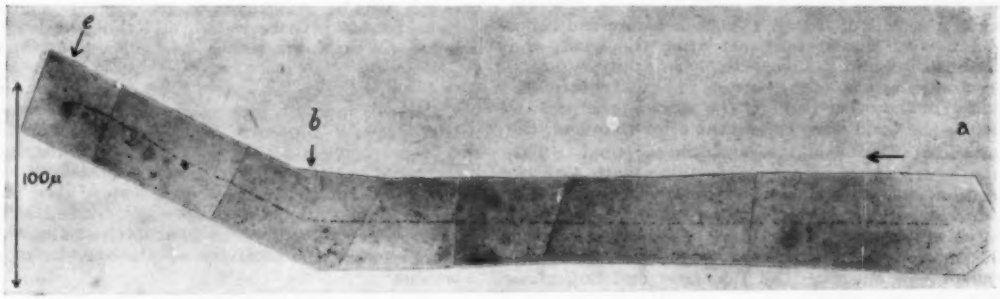
Table 1. *P*, portion of track in scale-divisions; *N*, number of grains in this portion

P	0–10	10–20	20–30	30–40	40–50	50–60	60–70
N	12	13	12	16	10	12	11
P	70–80	80–90	90–100	100–110	110–120	120–130	130–140
N	9	8	11	11	9	14	11
P	140–150	150–160	160–170	170–180	180–190	190–200	200–210
N	11	8	11	10	10	10	8

Fitting a straight line to these figures by the method of least squares, we obtain a line with a slope of 0·16 grains per ten scale divisions, per ten scale divisions, while the mean height at its centre is 10·8 grains per ten scale divisions. The standard deviation of the points from this line is 1·8 for a count of ten scale divisions. Since a scale division is 2·1 μ, it follows from these figures that the grain density near *b* is 0·60 $\pm$ 0·09, while at *a* it is 0·46 $\pm$ 0·09 grains/μ.

From our curves it follows that the residual ranges for these two grain counts are approximately 320 μ and 800 μ respectively if the particle is assumed to be a meson, giving a length of about 480 μ between the points *ba*. This is in fairly good agreement with the observed length of 420 μ. On the other hand, if the particle be assumed to be a proton, the residual ranges corresponding to grain counts of 0·60 and 0·46 grains/μ are 3,802 μ and more than 10,000 μ respectively, requiring the track length *ba* to be greater than 6,000 μ, in complete disagreement with the observed length. It can therefore be concluded with some confidence that the particle producing the track *ab* has not a protonic mass. However, since the mass determination now depends on the slope and length of the track *ba* and not on the total grain count against residual range, the determination is much less certain than in the case of the track *be*, and we cannot exclude the possibility of the particle having a mass a few times that of a π-meson.

The most obvious explanation of the bend at *b* is to assume that it is due to the scattering of a meson by collision with a nucleus in the emulsion. Now the energy and momentum of the particle just after the bend can be estimated from the grain count and the residual range, and is 1·5 $\pm$ 0·1 MeV. and 17·7 $\pm$ 0·7 MeV./*c* if the mass of the meson is assumed to be 200 m, where m is the mass of the electron. Similarly, the energy and momentum of the particle just before the bend are 3·3 $\pm$ 0·4 MeV. and 26·2 $\pm$ 1·3 MeV./*c* respectively. Since momentum is conserved, the momentum of the recoil nucleus can be deduced to be 13·8 $\pm$ 0·8 MeV./*c*. This gives it a kinetic energy of approximately 0·9 KeV., 1·2 KeV. or 0·1 MeV., depending on whether the recoil nucleus is that of silver, bromine, or hydrogen respectively. Hence even in the case of hydrogen the calculated energy is less than a tenth of what it should be for an elastic collision, namely, (3·3 $\pm$ 0·4) $-$ (1·5 $\pm$ 0·1) = 1·8 $\pm$ 0·5 MeV. Thus, if the bend is to be explained as due to scattering, we must conclude that the recoiling nucleus is excited to the extent of about 1·8 MeV. The possibility that the meson might have been scattered with emission of radiation can be ruled out almost completely because of its low velocity. The radiation loss of mesons is 40,000 times less than that of electrons, due to their greater mass. Moreover, even in the case of electrons, radiation loss becomes negligible compared with scattering at non-relativistic velocities, and this effect would still further diminish the chance of radiation loss relative to scattering for the meson under consideration. The



mechanism for the observed bend is clear. Assuming the nucleus to be a heavy one, like silver or bromine, one finds that a proton of 10 MeV. kinetic energy moving in a suitable direction in the nucleus could absorb the required amount of energy and momentum to explain the observed tracks. The extra energy acquired by the proton would be immediately divided among the other particles in the nucleus. If the track be due to a π-meson with a mass of 300 m, then a corresponding calculation shows that the track can also not be explained by an elastic collision. In this case the recoiling nucleus would be excited to the extent of about 2·7 MeV.

There is, however, another possible explanation of the track which we have to consider, namely, that at the point b a heavy particle decays *while in motion* into a lighter one, with the emission of a neutral particle, as, for example, a π-meson decaying into a μ-meson. Assuming different values for the mass m_l of the light meson and mass m_h of the heavy meson, the mass m_n of the neutral particle can be calculated. The result is shown in Table 2.

TABLE 2

m_l	m_h/m_l	m_h	m_n/m
170	1·5	255	79·5 ± 14·7
170	1·7	289	114·8 ± 21·2
200	1·5	300	93·6 ± 17·3
200	1·7	340	135·0 ± 24·9
300	1·5	450	140·4 ± 22·4
300	1·7	510	202·5 ± 32·4
300	3·33	1000	695·5 ± 111·2

Thus assuming the mass of the light meson to be 170 m and the ratio of the masses of the heavy and light mesons to be 1·7, as in the case of the π- and μ-mesons of Lattes, Powell and Occhialini[1], we find the mass of the neutral particle to be 0·68 ± 0·08 times that of the μ-meson, giving it a mass of 115 ± 21 m. Although this agrees within the limits of error with the mass of the neutral particle required by these authors, our calculated energy release would be 2·5 MeV., whereas they find an energy release of about 10 MeV. We are therefore inclined to believe that if our track is to be explained as a decay process at all, it would have to be the decay of a heavier particle into a π-meson. The only evidence for preferring such an interpretation to that of simple inelastic scattering is that the part of the track after the bend b shows noticeably greater scattering than before the bend. Some support for this visual impression can be obtained by a more quantitative measurement of the scattering along the track. The mean square of the scattering angle $\overline{\theta^2}$ in a length t of track varies inversely as the square of the kinetic energy E. Thus $E^2\overline{\theta^2}$ should depend only on the properties of the material for a particle of given mass. We have worked out the mean value of $E^2\overline{\theta^2}$ for eight intervals of length 15 μ each before the bend, and twenty similar intervals after the bend, and obtained 9·2 and 2·5 respectively in arbitrary units, assuming the mass of the particle to be 300 m throughout. On the other hand, if the mass of the particle before the bend were twice that after the bend, the values of $E^2\overline{\theta^2}$ would become more equal. This argument has, of course, to be taken with extreme caution, since the statistics are small and the fluctuations large. If the track observed by us is really to be interpreted as the decay of a heavier particle into a π-meson, then it cannot be identified with the process suggested by Rochester and Butler[2], as the last line of Table 2 shows. The mass of the neutral particle would have to be quite different.

We may summarize the above discussion by saying that the track reported by us is due to the scattering of a meson by a nucleus in which the nucleus is not disrupted but simply excited. Although we should expect such a process to occur, this is the first time that experimental evidence appears to have been obtained showing it.

We wish to express our thanks to Prof. H. J. Taylor for his invaluable assistance. We also wish to thank Mr. Malkarnekar for help in preparing the photomicrograph.

H. J. BHABHA
R. R. DANIEL
Tata Institute of Fundamental Research,
Bombay.
April 14.

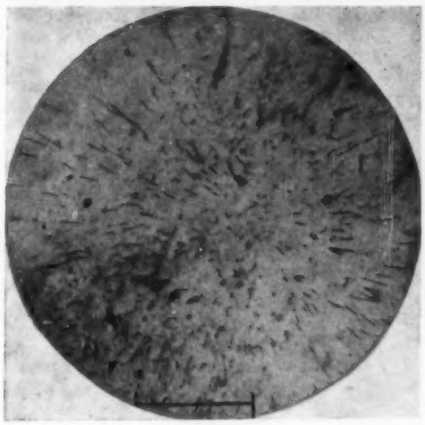
[1] Lattes, Powell and Occhialini, *Nature*, **160**, 453 and 486 (1947).
[2] Rochester and Butler, *Nature*, **160**, 856 (1947).

Investigation of the Radioactivity of Rocks by the Photographic Method

MADAME IRENE CURIE has pointed out[1] the feasibility of estimating the total uranium and thorium content of rocks by using the photographic method. H. Yagoda and N. Kaplan have more recently employed the method for determining the disintegration constant of U^{238}, getting values in concordance with previous results[2]. We have now tried the method on various rock specimens and the results obtained have been definitely encouraging. The method employed is to place an Ilford Nuclear Research plate at a distance of about 0·1 mm. from a flat surface of the specimen cut with a diamond saw, and expose it for one to three weeks, depending on the probable activity of the specimen. In more recent experiments the plate has been placed in contact with the cut surface, as this makes easier the identification of α-ray tracks, which all originate from one nucleus. Theoretically, from the frequencies of two-, three-, four- and five-ray stars, it should be possible to estimate the separate amounts of uranium and thorium present. Enough data have not yet been obtained to determine whether this method will prove possible.

As might be expected, the plates show that the distribution of the radioactive elements in rocks is sporadic. This specially applies to coarse-grained rocks such as granites: Fig. 1 is a photomicrograph of a very active spot obtained from a Finnish granite. More than two hundred tracks can be counted in the area shown, an area of about 7×10^{-4} cm.^{2}.

The average number of tracks for the same area taken over a gross area of 0·1 cm.^{2} was only about five. It will be seen that the tracks show a very definite tendency to be radial, and that the tracks increase in apparent length as they recede from the centre. The plate was separated from the rock surface by an air space of about 0·1 mm., so both observations agree with the view that the radioactive source is concentrated in a small volume of rock nearly opposite the centre of the photograph. This would agree with the usual hypothesis of the method of formation of pleochroic halos. The fact that for some rocks such large local concentration of activity occurs renders the quantitative estimation of the average radioactivity of these rocks more laborious.



100 μ

Fig. 1

It must be remembered that some of the α-tracks observed may be due to radioactive elements present either in the glass of the plate or possibly even the emulsion. This question has been investigated by developing some of the plates without exposure to any rock, and as might be expected, a fair number of tracks, most of which originate in the glass, were found. Two-, three-, four- and one five-ray star were observed: Fig. 2 is a photomicrograph of a four-rayed star which apparently actually originates in the emulsion, but such stars are rare. A rough estimate gives the number of these tracks as about 0·1 track per cm.² per hour. Fortunately, as the great majority of these tracks originate in the glass, it is fairly easy to distinguish them from the α-tracks from the rock. Alternatively, the tracks on a part of the plate which has not been exposed to the rock can be counted, and the necessary correction applied to the figure obtained for the portion exposed to the rock.

The presence of these α-ray stars in our plates would seem to cast some doubt on H. E. Huntley's hypothesis that similar stars observed in plates exposed at 11,000 ft. are due to cosmic rays[3]. Our plates have been kept at sea-level, and hence their exposure to cosmic rays has been small. To date, only one undoubted cosmic ray disintegration of an atom has been found, and yet the frequency of the stars observed is at least as high as that found in Huntley's plates. It would, as a matter of fact, be surprising if the glass of the plates were so free from radioactive materials that the small number of stars observed was not present. Probably the main source of the radioactive elements is the optical sand used in the manufacture of the glass, and it would not be expected that the radioactive elements present in the sand would be nearly totally eliminated during the process of manufacture.

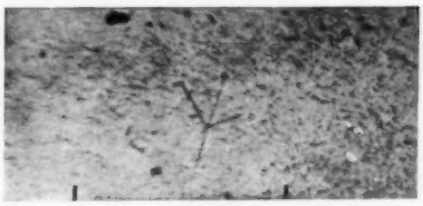


Fig. 2

J. H. J. Poole
J. W. Bremner

Trinity College,
Dublin.
April 15.

[1] Joliot-Curie, I., *J. Phys. et le Rad.*, **7**, 313 (Nov. 1946).
[2] Yagoda, H., and Kaplan, N., *Phys. Rev.*, **72**, 356 (1947).
[3] Huntley, H. E., *Nature*, **161**, 356 (1948).

Lightning Arrester Discharge Currents

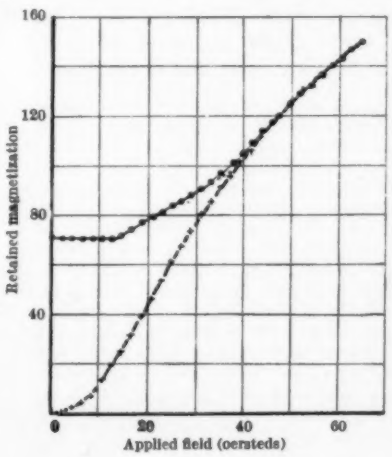
During the last five years an investigation has been made of the discharge currents of a number of 38,000-volt lightning arresters. The transmission system on which these arresters were installed is operated with its neutral point earthed through Peterson coils; the lines are not equipped with overhead ground wires. The earth lead of each single-phase arrester was equipped with a pair of magnetic links. In addition, paper-puncturing recorders were used to indicate when arresters had operated.

Among the results obtained last season were two of particular interest. The pairs of links involved were evaluated by the new step-method put forward by Prof. H. Norinder[1]. From the results it was apparent that the links had not been magnetized by a unidirectional current discharge. Reversals of direction of current flow were clearly indicated and could be evaluated. The magnitudes of the discharges were also evaluated by the older method[2] of comparing the relative magnetizations of the inner and outer links, assuming the presence of a single reversal. The values obtained were as follows:

Result No.	Norinder method		Value derived from relative magnetization of inner and outer links (amp.)
	Inner link evaluation (amp.)	Outer link evaluation (amp.)	
36 *S*	+1150, −390, +80	+1130, −370	+1220, −400
36 *T*	+1570, −250, +530	+1650,* − ?	+1590, −210

* Further evaluation of this link spoiled by a laboratory accident.

The characteristic curve obtained for the inner link of result No. 36 *T* is shown in the accompanying graph.



The Norinder method has been applied to the results obtained during the greater part of last year. Using this method, evidence of reversals of current flow have been obtained sufficiently frequently to show that it is not a rare phenomenon. In most cases, however, the discharges were not of sufficient magnitude to enable them to be evaluated with any degree of accuracy.

There would appear to be four possible explanations for the reversals observed : (*a*) Reversal of direction of current flow in the originating lightning flash itself[2–5]. (*b*) The record was the combined result of two or more flashes, that is, one flash made direct contact with the line conductor, others being a near miss or possibly also making contact with the conductor but being of opposite polarity. The flashes in question would have to occur within a maximum period of about five minutes or else they would have been recorded as separate punctures on the paper-band recorders. (*c*) A multiple flash, the component strokes of which did not all make contact with the line. (*d*) Restriking inside the arrester after the first current zero[6]. Many more data are required to elucidate this matter.

Unless the new method of evaluation is used, the presence of reversals such as those reported above can lead to erroneous interpretation of magnetic link observations of arrester discharge currents. This is especially liable to occur in the case of the more common small current discharges, as in such cases it is not possible to detect reversals by comparison of inner and outer link magnetizations since the outer link magnetization will be almost negligible.

It is hoped to publish fuller details of these investigations at a later date.

ROBERT C. CUFFE

Science Buildings,
University College,
Dublin.
Feb. 12.

[1] Norinder, H., *Ark. Mat. Ast. Fys.*, **31** A, No. 13 (1944).
[2] Surge Phenomena, E.B.A. Report, p. 70 (1941).
[3] Wagner, C. F., McCann, G. D., and Beck, E., *Trans. Amer. Inst. Elect. Eng.*, **60**, 1, 222 (1941).
[4] McEachron, K. B., *Elect. Eng.*, **60**, 885 (1941).
[5] Norinder, H., *Frank. Inst. J.*, **244**, 167 (1947).
[6] McCann, G. D., and Beck, E., *Trans. Amer. Inst. Elect. Eng.*, **66** (1947).

Effect of Lattice Distortions on the Mean Rate of Propagation of Large Barkhausen Discontinuities

THE well-known experiments by Sixtus and Tonks[1] on the propagation of large Barkhausen discontinuities have been repeated and extended, using slightly more refined methods.

The relation between the mean rate of propagation, V, and the external field, H,

$$V = A\,(H - H_0) \qquad (1)$$

was found to be strictly valid in all cases investigated.

Extensive experiments on a 60–40 nickel–iron alloy (which for this purpose has certain advantages over other alloys[2]) showed that A is very sensitive to defects in the lattice structure, an effect which hitherto seems to have escaped notice.

Table 1 refers to data obtained on a wire which was cold-drawn to a diameter of 0·01 cm. and then annealed at increasing temperatures, the highest (1,000° C.) including a slow cooling in a magnetic field. After this the wire was plastically stretched by a few per cent and measurements of A and H_0 again made.

TABLE 1

Condition of the wire	λ (cm.)	R ($\mu\Omega$/cm.)	H_0 (Oe)	A (cm./sec. Oe)
I	8·0	75	2·70	11,000
II	9·0	63	2·00	14,000
III	8·5	69	0·11	42,000
IV	11·5	—	0·08	38,000
V	10·0	71·8	0·56	35,000

I, cold drawn state.
II, I followed by heating for 4 hr. at 420° C. in hydrogen.
III, II followed by heating for 1 hr. at 850° C. in hydrogen.
IV, III followed by heating at 1,000° C. and slowly cooling in magnetic field.
V, IV followed by plastically stretching by a few per cent.

The last column and the last column but one contain the measured values of the constant A and H_0 in equation (1). There is a clear inverse relationship between the two quantities.

The length, λ, of the discontinuity does not vary much as a result of either cold work or annealing (cf. col. 2, Table 1).

The heat-treatment at 420° C. was aimed at producing the maximum amount of ordering in the lattice compatible with the cold-worked state. The effect of this treatment on the electric resistance, R, of the wire is very marked (cf. col. 3, Table 1), but the accompanying change in A is nevertheless small. Moreover, it is opposite in sign to the change to be expected as a result of an increased eddy-current damping.

The rate of propagation of the discontinuity in the cold-worked sample is not entirely uniform, as is indicated by the presence of irregularities in the oscillogram giving the voltage induced in the test coils surrounding the wire as a function of the time. In carefully annealed wires, on the contrary, propagation is quite smooth and at a constant rate.

Measurements were also made at the temperatures of liquid air and boiling water. This was done by passing these liquids through a glass tube surrounding the specimen.

These experiments brought to light a surprising effect, namely, that for a given wire the ratio A/R is practically independent of the temperature (cf. Table 2).

TABLE 2. NI–FE 60–40 ; DIAMETER OF WIRE, 0·01 CM. MEASUREMENTS AT T_1 = 93° K. ; T_2 = 287° K. ; T_3 = 368° K.

Cold-drawn state A_2 = 11,900 cm./sec. Oe					Annealed at 850° C. A_2 = 42,250 cm./sec. Oe				
T/T_2	A/A_2	R/R_2	H_0	λ	T/T_2	A/A_2	R/R_2	H_0	λ
0·32	0·35	0·36	3·36	10	0·33	0·34	0·37	0·11	10
1·00	1·00	1·00	2·44	10	1·00	1·00	1·00	0·03	10
1·28	1·36	1·39	2·20	10	1·28	1·37	1·41	0·05	10

To a less extent it might also be said that A is proportional to the absolute temperature in the region studied. Since we know of no other way of accounting for the observed substantial decrease in A with decreasing temperature except by assuming an increase in the eddy-current losses, we are inclined to suggest that perhaps a more refined eddy-current theory which makes due allowance for the fact that the rate of propagation in cold-worked samples is not uniform might account for all the facts.

A more complete account of our measurements will appear in due course in the *Philips Research Reports*.

L. J. Dijkstra
J. L. Snoek

Natuurkundig Laboratorium der
N.V. Philips' Gloeilampenfabrieken,
Eindhoven.
Jan. 27.

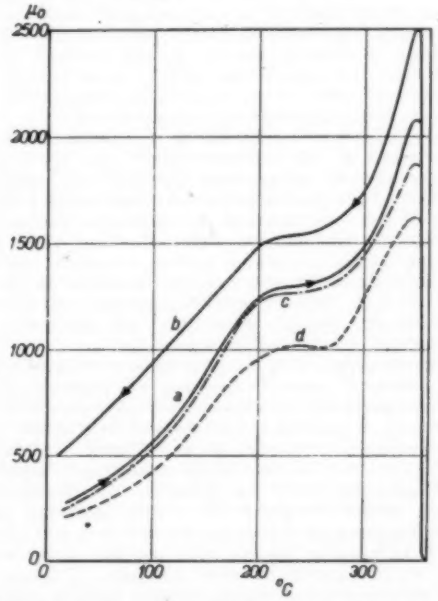
[1] Sixtus, K. J., and Tonks, L., *Phys. Rev.*, **42**, 419 (1932).
[2] Kersten, M., *Z. Tech. Phys.*, **19**, 546 (1938).

Metastable States of Nickel Characterized by a High Initial Permeability

In text-books on the subject, it is usually tacitly assumed that the initial permeability, μ_0, of a ferromagnetic material not subject to ordering, ageing or allotropic transformations is a unique function of the temperature. We have found that this is not true for pure and well-annealed nickel.

Circular bars having a diameter of 4·5 mm. and a length of 250 mm. were examined by us in an arrangement permitting the measurement of μ_0 at any temperature between room temperature and the Curie point without displacing or touching the sample. The temperature could be varied at a mean rate of about 20° C. per minute.

It was found that the curve for μ_0 when taken at rising temperatures differs markedly from the curve obtained at decreasing temperatures (see accompanying graph). The new value of μ_0 at room temperature is nearly double that observed after demagnetizing and is appreciably higher than any value reported so far in the literature[1].



VARIATION OF THE INITIAL PERMEABILITY OF NICKEL WITH TEMPERATURE:

(*a*) at increasing temperatures; (*b*) at decreasing temperatures starting from a temperature slightly above the Curie point; (*c*) curve found after demagnetizing the sample at the temperature of the measurement; (*d*) curve found after slightly tapping the arrangement at the temperature of the measurement. Curves (*c*) and (*d*) are independent of the previous heat-treatment.

Slightly tapping the arrangement or demagnetizing the sample brings the initial permeability down to values which—though mutually different—are independent of the previous heat-treatment. A waiting period of twenty-four hours usually brings the permeability down a good deal. It was assumed by us that this might be due to slight vibrations in the building. Measurements in quieter surroundings—a small observatory—confirmed this view. The abnormally high value of μ_0 in the observatory remained constant for periods varying between ten minutes and many hours, after which a sudden—usually small—decrease in μ_0 occurred.

Observations with a vibration indicator showed that the basement of the observatory—though much quieter than our previous surroundings—also was not absolutely at rest.

Our observations thus seem to show that temperature agitation itself does not bring about the more stable condition, but that small mechanical shocks or a demagnetizing treatment are required.

In order to bring about an abnormal increase of μ_0, it is not necessary to heat the sample at a temperature above the Curie point. Actually a variation of the temperature by $\pm$ 100° suffices to bring about an abnormal increase in μ_0.

A more complete account of the measurements will appear in the *Philips Research Reports*.

J. L. Snoek
J. F. Fast

Natuurkundig Laboratorium der
N.V. Philips' Gloeilampenfabrieken,
Eindhoven.
Jan. 27.

[1] Kirkham, Don, *Phys. Rev.*, **52**, 1162 (1937).

Audio-Frequency Magnetic Fluctuations

A recent letter by Menzel and Salisbury[1] raises the question of the existence in Nature of electromagnetic waves of audio-frequencies and refers to observations covering the range 25–400 c./s. Magnetic fluctuations at these frequencies have been recorded at the Admiralty Research Laboratory, and on various occasions during the past year field measurements have been made, including some at an isolated site on Bodmin Moor, Cornwall, remote from man-made sources of electric disturbance. These measurements covered the range 5–1,000 c./s.

The detector consisted of a coil wound on a long laminated mu-metal core, the complete unit being light and easily portable. The signals were amplified, and measured by a wave analyser having a pass-band of 4 c./s. The entire equipment was operated from batteries.

At the higher frequencies the magnetic fluctuations are very weak, and the principal difficulty in the design of the equipment is to keep the resistance noise of the detecting coil adequately below the level of the 'magnetic noise' to be measured. To be certain that any one reading was due to magnetic noise and not to the noise of the coil itself was not always easy. Latterly, however, we have employed two similar coils for reception, located parallel to one another, sufficiently separated to make their magnetic coupling small, but at the same time close enough to ensure that their responses to magnetic fluctuations are in phase. If the coils are connected in series, the effects of the magnetic fluctuations reinforce one another; but if they are connected in opposition, these effects

are cancelled. In the case of resistance noise it makes no difference which way the coils are connected provided their coupling is small. By switching the coils in series and opposition at each reading, it is then easy to decide to what extent any one measurement is due to genuine magnetic fluctuations.

The accompanying table gives typical values for the fluctuations of the horizontal magnetic field measured at Bodmin Moor in April and November 1947. These fluctuations were the same in all directions of the horizontal plane:

Frequency	Magnetic fluctuations for 1 c./s. pass band*
5 c./s.	6×10^{-9} Gauss
10	3×10^{-9}
20	8×10^{-9}
40	5×10^{-9}
100	1×10^{-9}
200	5×10^{-10}
400	7×10^{-11}
800	4×10^{-11}

* If these magnetic fluctuations were the magnetic components of an electromagnetic wave field, the corresponding electric field values, measured in micro-volts per metre, would be obtained by multiplying the above magnetic values by 3×10^{10}.

It is considered that these fluctuations are of natural origin. The absence of any directionality in the horizontal plane suggests that the fluctuations do not arise from the nearest highly populated area (Plymouth); and furthermore, the results showed no trace of the line spectrum obtained in such a populated area, other than a weak signal at 50 c./s.

The noise values show a rapid decrease with frequency, roughly inversely as the power 3/2. Beyond 1,000 c./s. it has not been possible to detect magnetic fluctuations above the noise of the existing detector system, and the observations suggest that there may exist a very silent region of the spectrum between 1,000 c./s. and the lowest radio frequencies.

Although the magnetic noise showed no directionality in the horizontal plane, it was often much less in the vertical direction, even at frequencies as low as 20 c./s. It is possible that this is due to eddy currents set up in the earth. If we suppose, for example, that the magnetic fluctuations arise from distant current movements in the atmosphere, near the earth's surface, then theory shows that the magnetic fields which they produce at ground-level at sufficiently large ranges will be largely horizontal, even at very low frequencies. In the experiments described above, the attenuation of the vertical fluctuations may have been accentuated by the fact that the ground was wet at the time. Above dry ground one would expect greater vertical fluctuations.

H. F. Willis

Admiralty Research Laboratory,
Teddington, Middlesex.
Feb. 17.

[1] Menzel and Salisbury, *Nature*, **161**, 91 (1948).

Structure of Plasteins

The molecular weight of the 'plastein' precipitated from a pepsin hydrolysate of egg albumen at *p*H 4 was found to be about 300 in determinations performed cryoscopically in a phenol solution[1]. Since the average molecular weight of peptides in pepsin hydrolysate is between 300 and 400 [2], no lengthening of peptide chains seems to take place in the formation of plastein, still less protein synthesis, as had generally been thought. For this reason we regarded the plasteins as being constituted of mixtures of cyclic peptides which are formed under the influence of certain proteolytic enzymes from low-molecular peptides in protein hydrolysates[1]. Of the earlier investigators, Folley[3] alone has supported the view of the low molecular-weight structure of plasteins.

In further studies on the formation and nature of plasteins, we employed chiefly the pepsin hydrolysate of zein. Crystalline pepsin was regularly used.

(1) The molecular weight determined by the cryoscopic method in a phenol solution was ascertained to be about 300 with three preparations of zein plastein. The values in phenol solutions are, however, too low as derived from the results of plastein hydrolysis recorded below. The average molecular weight of the known amino-acid residues in zein and plastein is about 116.

(2) The formation of plastein with pepsin has a strong maximum at *p*H 4. On the acid side, the limit of the reaction is at about *p*H 2·5; on the alkaline side about *p*H 7.

(3) The amino-acid composition of plastein and zein are very similar when the values are calculated on amide-free material. Since the amide-nitrogen chiefly splits off in the pepsin hydrolysis in the form of ammonia, the plastein preparations of zein contain only two to three per cent of the total nitrogen as amide-nitrogen. We found in zein-plastein (the values for zein[4] are in brackets): arginine + histidine 7·1 (7·0), glutamic + aspartic acids 23·1 (23·1), alanine + valine + leucine + *iso*leucine + phenylalanine + methionine 39·6 (39·3), proline 8·7 (9·7), tyrosine 3·6 (3·1). All values refer to amino-acid nitrogen as a percentage of total nitrogen in amide-free material.

The results of analyses suggest that the amino-acid composition of plastein corresponds roughly to that of protein. The differences in the proline and tyrosine values seem, however, to indicate that small variations may exist regarding some amino-acids. The analysis of the amino-acid groups derived from hydrolysate of egg albumen also gives an indication of the similarity of the amino-acid composition in protein and in the corresponding plastein.

(4) The free acid and basic groups in plastein were determined in two different ways. (*a*) We found on the basis of the safranine fixation[5] the quantity of the acid groups in zein plastein (containing 1·9 per cent of the total nitrogen as amide-nitrogen) to be $19{\cdot}4 \times 10^{-4}$ mol. per gm. The calculated value for cyclic peptides (the groups binding safranine: aspartic acid, glutamic acid, tyrosine, cysteine) is about 22×10^{-4}, for open tripeptide chains about 60×10^{-4}, and for pentapeptide 45×10^{-4}. The agreement is thus fairly good for cyclic structure.

(*b*) Titration with 0·1 *N* sodium hydroxide solution with a water suspension of plastein using thymol phthalein as indicator revealed that $22{\cdot}9 \times 10^{-4}$ mol. of sodium hydroxide had been bound per gm. plastein. Formol titration gave the value 21×10^{-4}. On the basis of the quantities of aspartic and glutamic acids in plastein, the theoretical value would be about 21×10^{-4} mole per gm. plastein, when cyclopeptide is concerned, and about 42×10^{-4} in the case of open peptide chains with one amino-dicarboxylic acid residue.

Determination of amino-nitrogen by Van Slyke's method (a plastein preparation dissolved in borate–sodium hydroxide solution at *p*H 10·0) gave the following values: 5 min. shaking, 4·4 per cent, 30 min. shaking, 6·8 per cent of total nitrogen. The small quantity of amide-nitrogen and a part of the arginine nitrogen may have reacted in the first place

with nitrite. This result, too, supports the cyclic structure of plastein.

(5) Plastein is formed in the pepsin hydrolysates of all proteins examined which contain abundantly amino-dicarboxylic acids. Gliadine, which contains 25·5 per cent of total nitrogen as amino-dicarboxylic acid-nitrogen, yields under the same conditions more plastein than does zein containing 18·8 per cent amino-dicarboxylic acid-nitrogen. On the other hand, amino-nitrogen did not decrease and plastein could not be obtained with papain nor with pepsin, in a papain hydrolysate of gelatine, although plastein is precipitated from the papain hydrolysate of zein with both enzymes. The results so far seem to indicate that the acid groups in the peptides are indispensable for the formation of plastein. In a mixture containing glycyl-glycine, glycyl-*l*-leucine, *l*-leucyl-*l*-tyrosine, *l*-leucyl-glycyl-glycine, *dl*-alanyl-glycine, chloracetyl-*l*-tyrosine and hippuryl-glycine, amino-nitrogen was not lowered by pepsin action at *p*H 4, nor was plastein precipitated.

(6) In the trypsin hydrolysates of zein and casein, pepsin produced at *p*H 4 only 1–1·5 per cent plastein of the weight of protein used. In corresponding circumstances, ten to fifteen times more plastein was obtained from pepsin hydrolysates. Since pepsin and trypsin break the peptide bonds of protein at different points, it probably explains the difference. In the pepsin hydrolysis of zein, the peptide chain seems to break at the point nearest glutamic acid[2].

(7) Plasteins are slowly hydrolysed in hydrochloric acid at *p*H 1·5 at the opening of the ring. The reaction takes place much more rapidly under the action of pepsin in the same conditions. Acid hydrolysis (*p*H 1·5 and 37° C.) without pepsin brought 67 per cent of the plastein into solution in 33–55 days. On the basis of the amino-groups set free the average molecular weight of cyclopeptides would be the same as that of tetrapentapeptides. In the soluble and insoluble fraction the amount of amino-dicarboxylic acids seems to be practically the same, which supports the idea of each cyclopeptide molecule having one amino-dicarboxylic acid residue. On the contrary, proline is accumulated in the insoluble fraction. The soluble fraction, again, contains considerably more basic acids as well as acids of the group alanine + valine + leucine + *iso*leucine + phenylalanine + methionine than does the insoluble fraction.

The elementary composition of zein plastein (water and ash-free material) was as follows: C = 54·3, H = 7·6, N = 12·9 (calculated values for cyclic peptides: C = 54·1, H = 7·1, N = 13 8). Nitrogen of the amino-acids hitherto estimated in zein accounts for 94 per cent of the total nitrogen. The rest of the nitrogen is still of unknown nature. The calculated values are therefore only approximate.

We regard the present results as confirming the concept of the cyclic structure of plasteins. A detailed account of our work and further developments will be published in *Acta Chemica Scandinavica*.

ARTTURI I. VIRTANEN
HEIKKI K. KERKKONEN

Biochemical Institute,
Helsinki.
Jan. 27.

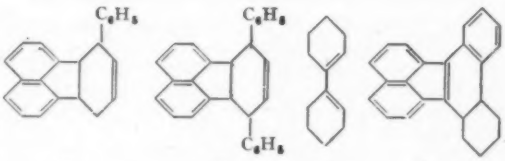
[1] Virtanen and Kerkkonen, *Acta Chem. Scand.*, **1**, 140 (1947).
[2] Laine, *Ann. Acad. Sci. Fenn.*, Ser. A. II, Chem. No. 11 (1944).
[3] Folley, *Biochem. J.*, **26**, 99 (1932).
[4] Chibnall, *J. Intern. Soc. Leather Trades' Chem.*, **30**, 1 (1946).
[5] Fraenkel-Conrat and Cooper, *J. Biol. Chem.*, **154**, 239 (1944).

A Synthesis of Fluoranthene Derivatives

IN a recent investigation[1], the theory has been put forward that the formation of aromatic hydrocarbons in the high-temperature cracking of petroleum or petroleum fractions is due to diene syntheses between butadiene, which is one of the primary cracking products, and olefinic hydrocarbons. It occurred to us that fluoranthene (I), which is a characteristic product of this aromatizing cracking, may be formed from acenaphthylene and butadiene by the following reaction:

I

It has, indeed, been found that acenaphthylene reacts easily at 160–200° with dienes to give hydrogenated substituted fluoranthene derivatives: from 1-phenyl-butadiene and 1·4-diphenyl-butadiene, for example, 10-phenyl- and 10 : 13-diphenyl-9 : 10 : 13 : 14-tetrahydro-fluoranthene (II, III) have been obtained.



II III IV V

Compound (II) had m.p. 156°, after recrystallization from alcohol (calc. for $C_{22}H_{18}$: C, 93·6; H, 6·4; found: C, 93·6; H, 6·4), and (III) had m.p. 202°, after recrystallization from chlorobenzene (calc. for $C_{28}H_{22}$: C, 93·9; H, 6·1; found: C, 93·6; H, 6·1).

With dicyclohexenyl (IV) the condensation seems to be accompanied by partial dehydrogenation and the analysis of the product corresponded to formula (V), of a 10 : 11-benzo-12 : 13-tetramethyleno-12 : 13-dihydro-fluoranthene[3]; it crystallized from a mixture of chlorobenzene and butyl acetate as a white, crystalline powder (calc. for $C_{24}H_{18}$: C, 94·1; H, 5·9; found: C, 93·9; H, 5·7).

It is interesting to note that sorbic acid behaves also as a diene[4]; in the course of the condensation with acenaphthylene, however, the carboxyl group is split off.

Acenaphthylene behaves, therefore, towards dienes like indene[4] and certain styrene derivatives[5]. This is in keeping with the fact that it contains an evidently very reactive double bond which makes the hydrocarbon also prone to polymerization and co-polymerization reactions[6,7].

A detailed description of the experiments will follow when the obvious possibilities of extension of this reaction will have been explored. It becomes possible to determine the position of substituents entering the fluoranthene molecule[8], from the location of substituents in the acenaphthene molecule, the

reactions of which have been thoroughly investigated[9].

E. BERGMANN

Daniel Sieff Research Institute,
Rehovoth.
Nov. 28.

[1] Weizmann, Ch., and co-workers, *Ind. Eng. Chem.* (in the press).
[2] Such dehydrogenation has also been observed in the reaction of acenaphthylene and tetracyclone (Dilthey, Henkels and Schaefer, *Ber.*, **71**, 974 (1938)).
[3] This has been observed before in some isolated instances: Diels and Alder, *Liebigs Ann.*, **470**, 91 (1929). Farmer and Warren, *J. Chem. Soc.*, 906 (1929). Wagner-Jauregg and Helmert, *Ber.*, **71**, 2535 (1938). Wicks, Daly and Lack, *J. Org. Chem.*, **12**, 713 (1947), who also observed decarboxylation in the course of the reaction.
[4] Alder and Rickert, *Ber.*, **71**, 379 (1938). See Bergmann, E., and Bergmann, F., *J. Amer. Chem. Soc.*, **60**, 1805 (1938).
[5] Hudson and Robinson, *J. Chem. Soc.*, 715 (1941). Tamayo, *Chem. Abs.*, **41**, 4468, 6539, 6840 (1947).
[6] See, also, for references, Flowers and Miller, *J. Amer. Chem. Soc.*, **69**, 1388 (1947).
[7] Acenaphthylene shows dienophilic properties also towards tetracyclone and acecyclone: Dilthey and co-workers (ref. 2).
[8] See v. Braun and co-workers, *Ber.*, **63**, 2608 (1930); **67**, 4051 (1934); *Liebigs Ann.*, **488**, 111 (1931); **496**, 170 (1932). Tobler *et al.*, *Helv. chim. Acta*, **24**, 100 E (1941).
[9] It is substituted in 5-position (see, for example, Fleischer and Wolff, *Ber.*, **53**, 925 (1920). Dziewonski and Spirer, *Bl. Acad. Polon.*, A, 232 (1931). Liebermann and Zsuffa, *Ber.*, **44**, 207 (1911); but sulphonation at 100° attacks the 3-position (Dziewonski *et al.*, *Chem. Zentralbl.*, **97**, II, 2816 (1926); Dziewonski and Stolyhwo, *Ber.*, **57**, 1531 (1924); Morgan and Yarsley, *J. Soc. Chem. Ind.*, **44**, 513T (1925)).

Chemical Mechanism of Permanent Set

THE permanent set which strained wool fibres acquire in steam or boiling water is believed to be due to two consecutive intramolecular reactions, namely, hydrolysis of the disulphide bonds to give sulphenic acid and mercapto side-chains, followed by condensation of the sulphenic acid, or the aldehyde to which it gives rise on decomposition, with the basic side-chains of lysine and arginine[1]. Disulphide bond breakdown promotes relaxation, and the relaxed structure is stabilized by the new cross-linkages. The main evidence that the basic side-chains play an essential part in the linkage-rebuilding reaction is the failure of deaminated fibres to acquire a permanent set in steam. It seemed desirable that further evidence should be obtained because of recent suggestions[2] that the breakdown and re-formation of hydrogen bonds between the peptide chains may be sufficient to impart a permanent set to strained fibres. The setting power of wool treated with 2 : 4-dinitrofluorobenzene has therefore been examined.

Purified Lincoln root wool was treated with 2 : 4-dinitrofluorobenzene according to Sanger's procedure[3]. The wool (0·2 gm.) was first wetted out with a solution of sodium bicarbonate (0·2 gm.) in water (5·0 ml.). After adding a solution of 2 : 4-dinitrofluorobenzene (0·2 ml.) in ethanol (10 ml.), the wool was heated in the reagent for 23 hours at 40° C., the resulting gain in weight being 9·4 per cent. For reference purposes, a further sample of wool was treated with all the reagents except 2 : 4-dinitrofluorobenzene for 23 hours at 40° C. The setting power of these wools was then compared with that of untreated wool.

Each fibre was stretched 40 per cent in distilled water and set by immersion in a boiling 2 per cent solution of borax for 30 minutes. To determine the extent and permanence of the set, the fibre was then released in boiling water and its length redetermined at intervals. A summary of the results is given in the accompanying table, each value being the mean of ten observations on different fibres.

Wool	Percentage set retained after release in boiling water for 0 min.	2 min.	15 min.	60 min.
Untreated	40·0	26·1	25·3	24·4
Buffer-treated	40·0	24·0	23·2	21·0
Treated with 2 : 4-dinitrofluorobenzene	40·0	16·9	15·3	11·8

Since the setting power of wool is reduced to such a striking extent by treatment with 2 : 4-dinitrofluorobenzene, it seems reasonable to conclude, in accordance with earlier evidence, that the free amino-groups of wool play an essential part in the cross-linking reaction which is responsible for permanent set.

We are indebted to Mr. W. R. Middlebrook for the preparation of the wools used in this investigation.

A. J. FARNWORTH
J. B. SPEAKMAN

Textile Chemistry Laboratory,
Department of Textile Industries,
University, Leeds.
Feb. 3.

[1] Speakman, *J. Soc. Dyers and Colourists*, **52**, 335 (1936).
[2] Rudall, "Fibrous Proteins", 15 (Society of Dyers and Colourists, 1946). Phillips, *ibid.*, 39.
[3] Sanger, *Biochem. J.*, **39**, 507 (1945).

Energy of the Central C–C Bond in Diphenyl

THE value of the energy of the central C—C bond in diphenyl (that is, the heat of dissociation of the molecule into two radicals (or atoms) formed by the fission of this bond) is of considerable interest. The difference between the energy of this bond and the energy involved in the C—C bond of ethane provides a measure of conjugation which was generally considered as 6–8 kcal. only[1]. We use the following two thermochemical equations for the calculation of the energy of the central C—C bond in diphenyl:

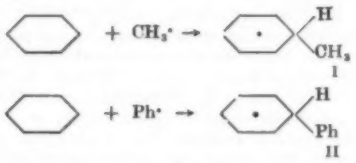
$$\Delta H_f(C_6H_5.C_6H_5) = 2\Delta H_f(C_6H_6) - D(C\text{—}C);$$
$$2\Delta H_f(C_6H_6) = 2\Delta H_f(C_6H_5) + 2\Delta H_f(H) - 2D(C\text{—}H).$$

The heats of formation of diphenyl and benzene were estimated by Huffman[2] as 20·8 kcal./mole for solid diphenyl and 11·6 kcal./mole for liquid benzene. The heat of sublimation of diphenyl is 16·4 kcal./mole[3], that of vaporization of benzene 8·1 kcal./mole. For the C—H bond energy in benzene we accept the suggested value of 106 kcal.[4], which seems to be very plausible. Thus we obtain for the central C—C bond energy in diphenyl a value of 110 kcal. Its strengthening as compared to the C—C bond in ethane is 25 kcal., which shows how considerable is the contribution of the conjugation to the bond energy. This strengthening effect makes it possible to predict the length of the central C—C bond in diphenyl as 1·43–1·45 A., using the relationship between the bond energy and bond length.

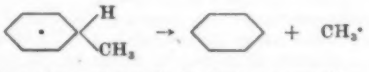
There are two experimental studies dealing with the length of this bond. Dhar used the rotating crystal X-ray technique[5]; his value is 1·48 A., the estimated accuracy being about 10 per cent. Karle and Brockway[6] used an electron diffraction method. Assuming that both phenyl rings are regular hexagons having sides of 1·39 A., they find for the central C—C bond a length of 1·54 A.; if they assume the hexagons

to be slightly irregular, having sides of 1·38 A. and 1·40 A., it is 1·48. In view of the great strengthening of this C—C bond, found in the present work, it seems that it has a high degree of double-bond character, which implies that the phenyl hexagons are strongly deformed. Therefore we suggest that the correct value for the central C—C bond in diphenyl which should be obtained from the electron diffraction study is even less than 1·48 A. The assumption that the hexagonal rings in diphenyl are irregular is supported by Jeffrey's work[7], which indicates the irregularity of the phenyl rings in dibenzyl.

Chemical evidence also indicates that the energy of the central C—C bond in diphenyl is considerably increased and is certainly greater than 106 kcal. It is known[8] that free radicals produced in solutions of aliphatic hydrocarbons extract hydrogen from them. Methyl radicals thus produce methane and phenyl radicals give benzene. In benzene solution, however, methyl radicals do not extract hydrogen at all, and phenyl radicals react giving diphenyl. To show that this is the result of a reaction with benzene, and not a result of the dimerization of phenyl radicals, chlorobenzene was used as a solvent instead of benzene. In this solvent the main product of the reaction is *p*-chlorodiphenyl. We suggest that these facts should be explained by the following mechanism :



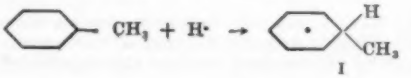
The point inside the ring symbolizes the odd electron. We may assume that the intermediates (I) and (II) stabilize themselves by releasing that component which is least strongly bound. In the case of (I), the most weakly bound component is CH_3 and the reaction is



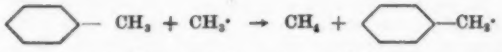
Therefore the net result is that no reaction occurs, as is observed experimentally. In the case of (II) the product is diphenyl, showing that the phenyl group is more strongly bound than the hydrogen atom.

We conclude, therefore, that the C—C bond of diphenyl is stronger than the C—H bond in benzene. This must be stronger than the C—H bond in methane, because the methyl radical is not able to extract hydrogen from benzene (whereas it can extract hydrogen from an aliphatic solvent).

Another argument in favour of the proposed mechanism is found in the observation of Szwarc[9] that hydrogen atoms can react with toluene giving benzene and methane. In this case the intermediate (I) is obtained by the reaction



and this decomposes, as stated above, giving benzene and the methyl radical which gives methane by the reaction :



The benzyl radicals, being very stable, are removed by dimerization. Hence the value of 110 kcal. for the central C—C bond in diphenyl is borne out by additional chemical evidence.

M. Szwarc

Chemistry Department,
The University,
Manchester 13.
Feb. 3.

[1] Pauling, L., "The Nature of the Chemical Bond", 137 (Cornell University Press, 2nd edit., 1940).
[2] Parks and Huffman, "Free Energy of Some Organic Compounds", 90 (Chemical Catalog Co., New York, 1932).
[3] Wolf and Weghofer, *Z. Phys. Chem.*, B, **39**, 194 (1938).
[4] Steacie, "Atomic and Free Radical Reactions" (Reinhold Pub. Co., 1946).
[5] Dhar, *Ind. J. Phys.*, **7**, 43 (1932).
[6] Karle and Brockway, *J. Amer. Chem. Soc.*, **66**, 1974 (1944).
[7] Jeffrey, *Proc. Roy. Soc.*, A, **188**, 222 (1947).
[8] Hay and Waters, *Chem. Rev.*, **21**, 169 (1937).
[9] Szwarc, *Nature*, **160**, 403 (1947); *J. Chem. Phys.*, **16**, 128 (1948).

Stress Corrosion

No really satisfactory explanation of stress corrosion (season-cracking) in brass and similar alloys has yet been offered, and in a recent critical review, Read, Reed and Rosenthal[1] were forced to conclude, somewhat unconvincingly, that stress corrosion might be due to an inherent susceptibility of crystal boundaries to corrosive attack on account of their 'lattice imperfection'. This view, however, would imply that grain boundary corrosion is a normal form of attack instead of being, as it is, abnormal.

It may be recalled that stress corrosion occurs only when susceptible alloys are internally stressed and then kept in certain specific corroding environments. These stressed alloys may be stored indefinitely in a pure atmosphere and, moreover, do not crack indiscriminately in all corroding media. Thus stressed brass does not crack in nitric acid (although, of course, it is attacked and dissolved), but cracks readily in air containing a mixture of ammonia, water vapour and carbon dioxide[2].

In speculating on possible mechanisms, I have previously suggested[3] that the basic cause might be selective chemical attack at the grain boundaries, localized by the formation of a protective film of corrosion product over the faces of the alloy crystals. Such a film might conceivably be protective only when its structure corresponds to the regular structure of the underlying crystals. At the grain boundaries where the regular structure of the alloy is interrupted, discontinuities in the adhering film might be expected. The effect of stress is considered to be simply that of widening the cracks first formed and thereby accelerating attack.

An observation made in these Laboratories on the stress corrosion of 9 ct. gold alloys in acidified ferric chloride solution lends support to this hypothesis. Alloys containing 37·5 per cent of gold with the balance made up of copper, silver and zinc, cold-rolled to about 80 per cent reduction in thickness, crack in less than five minutes in this solution. If, however, a sample, protected on one side with wax, is immersed so that the exposed surface bears against

a small rotating brush, no cracking can be detected after thirty minutes, although considerable general corrosion takes place.

It seems difficult to account for this result on any grounds other than that of the removal of a local protective film from the surface of the metal. It is hoped that it may be possible to continue this work and publish a more detailed study elsewhere.

J. C. CHASTON

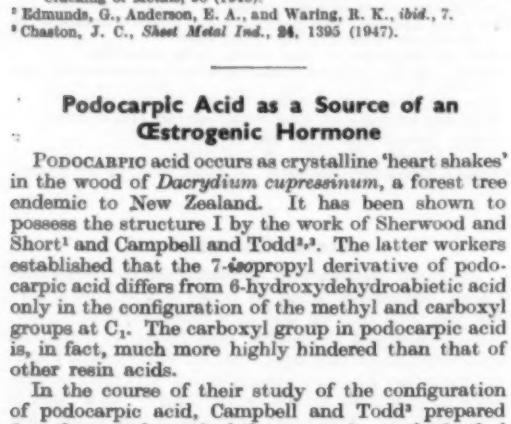
Research Laboratories,
Johnson, Matthey and Co., Ltd.,
Exhibition Grounds,
Wembley, Middlesex.
Feb. 18.

[1] Read, T. A., Reed, J. B., and Rosenthal, H., Amer. Soc. Test. Mat. and Amer. Inst. Mech. Eng., Symposium on Stress Corrosion Cracking of Metals, 90 (1945).
[2] Edmunds, G., Anderson, E. A., and Waring, R. K., *ibid.*, 7.
[3] Chaston, J. C., *Sheet Metal Ind.*, **24**, 1395 (1947).

Podocarpic Acid as a Source of an Œstrogenic Hormone

PODOCARPIC acid occurs as crystalline 'heart shakes' in the wood of *Dacrydium cupressinum*, a forest tree endemic to New Zealand. It has been shown to possess the structure I by the work of Sherwood and Short[1] and Campbell and Todd[2,3]. The latter workers established that the 7-*iso*propyl derivative of podocarpic acid differs from 6-hydroxydehydroabietic acid only in the configuration of the methyl and carboxyl groups at C_1. The carboxyl group in podocarpic acid is, in fact, much more highly hindered than that of other resin acids.

In the course of their study of the configuration of podocarpic acid, Campbell and Todd[3] prepared 6-methoxy podocarpinol (for conversion to the 1-ethyl compound by the Wagner Meerwein rearrangement) but did not demethylate to podocarpinol II.



Fieser and Campbell[4] had previously prepared 6-hydroxydehydroabietinol and found it to possess considerable œstrogenic activity. Since this compound differs from podocarpinol only in configuration at C_1 and the presence of an *iso*propyl group at C_7, it was thought that podocarpinol might also possess œstrogenic properties.

We have recently prepared podocarpinol through the route shown, which differs slightly from that employed by Campbell and Todd. Preliminary physiological tests carried out by I. G. Cunningham, of the Animal Research Station, Wallaceville, New Zealand, suggest that podocarpinol possesses œstrogenic activity.

Details of the preparation of this compound and of the physiological tests will be reported fully elsewhere. Other modifications of podocarpic acid of possible hormonal activity are also in course of preparation.

C. W. BRANDT
D. J. ROSS

Dominion Laboratory,
Dept. of Scientific and Industrial Research,
Wellington, New Zealand.

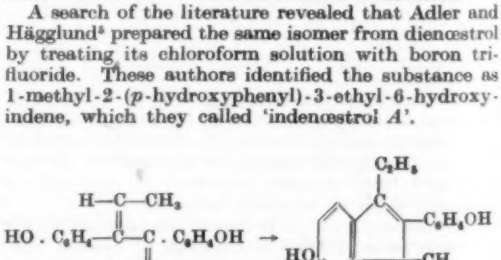
[1] Sherwood and Short, *J. Chem. Soc.*, 1006 (1938).
[2] Campbell and Todd, *J. Amer. Chem. Soc.*, **62**, 1287 (1940).
[3] Campbell and Todd, *J. Amer. Chem. Soc.*, **64**, 928 (1942).
[4] Fieser and Campbell, *J. Amer. Chem. Soc.*, **61**, 2528 (1939).

Isomerization of Dienœstrol

DURING experiments on the metabolism of dienœstrol in man and in animals it was noticed that hydrolysis of dienœstrol-containing urines, 1 *N* with respect to hydrochloric acid, always entailed a loss of about 90 per cent of the original œstrogenic activity. Further, chemical determination of the dienœstrol content of such urines by the method of Sahasrabudhe and Wilder Smith[1] showed an even greater loss of œstrogen after hydrolysis. In working out the latter method, dienœstrol was added to benzene extracts of hydrolysed urine, so that the added dienœstrol escaped the hydrolysis process. Afterwards it was found that hydrolysis of dienœstrol glucuronide[2] under similar conditions gave negligible yields of the free œstrogen (cf. Stroud[3]). On the other hand, the same hydrolysis technique (1 *N* hydrochloric acid, 3 hr. refluxing) gave excellent yields of hexœstrol from hexœstrol monoglucuronide. Thus it was suspected that the dilute acid was decomposing the dienœstrol liberated.

This was confirmed by treating dienœstrol (m.p. 232°) for 1 hr. under reflux with 1 *N* hydrochloric acid in a stream of nitrogen, when an 80 per cent yield of an isomer, m.p. 175–176°, was obtained which was not identical with Hobday and Short's[4] *iso*dienœstrol, m.p. 189°. Its acetate, benzoate and *p*-nitrobenzoate were prepared and shown to be isomeric with those of dienœstrol but not identical.

A search of the literature revealed that Adler and Hägglund[5] prepared the same isomer from dienœstrol by treating its chloroform solution with boron trifluoride. These authors identified the substance as 1-methyl-2-(*p*-hydroxyphenyl)-3-ethyl-6-hydroxyindene, which they called 'indenœstrol *A*'.



We have found this indene to possess about one tenth of the œstrogenic potency of dienœstrol, when tested by the method used in this Institute[6], thus

accounting for the originally observed losses of activity on hydrolysis of dienœstrol-containing urines.

It has been found that, as well as 1 *N* hydrochloric acid, 1 *N* sulphuric and 1 *N* phosphoric acids are equally effective in realizing the same cyclization. This presumably may take place by 1 : 4 addition of the elements of water or of the respective acid, followed by resplitting off of the hydroxy group or the acid radical with the hydrogen atom in the ortho position. Similar mild conditions were required for the cyclization of other comparable types of dienes. The addition of a trace of hydrogen chloride or concentrated sulphuric acid to a solution of dienœstrol in glacial acetic acid in the cold gave a good yield of the same cyclization product after a very short reaction period.

Fuller details will be published elsewhere.

W. Hausmann
A. E. Wilder Smith
(Countess of Lisburne Memorial Fellow)

S.A. Courtauld Institute of Biochemistry,
Middlesex Hospital,
London, W.1.
Feb. 23.

[1] Sahasrabudhe, M. B., and Wilder Smith, A. E., *Biochem. J.*, **41**, 190 (1947).
[2] Simpson, S. A., and Wilder Smith, A. E., *Biochem. J.* (in the press).
[3] Stroud, S. W., *J. Endocrin.*, **1**, 201 (1939).
[4] Hobday, G. I., and Short, W. F., *J. Chem. Soc.*, 609 (1943).
[5] Adler, Erich and Hägglund, Bengt, *Arkiv. för Kemi, Min. och Geol.*, **19** a, (23), 1 (1945).
[6] Wilder Smith, A. E., and Williams, P. C., *J. Endocrin.*, **5**, 152 (1947).

Glycerol Dichlorhydrin and Vitamin A

The use of 'activated' glycerol dichlorhydrin as a reagent for the colorimetric or absorptiometric estimation of vitamin A has been proposed by Sobel and Werbin[1]. As reported, the reaction appears attractive in view of the stability of the chromophor, which makes for ease of measurement. A disadvantage is the low activity of the reagent compared with chloroformic antimony trichloride (Carr–Price reaction); the *E*(1 per cent, 1 cm.) 550 mμ value per unit of vitamin A is only about 25 per cent of the corresponding *E*(1 per cent, 1 cm.) 620 mμ (Carr–Price) value. The pure compound does not react at all; 'activation' is effected by distillation with 1–2 per cent antimony trichloride[1]; but no account of what causes 'activation' has yet appeared.

It has been found here that the activating principle is hydrochloric acid (or, perhaps, hydrogen ions, in so far as sulphuric acid has some activating effect), small quantities of which are formed during distillation. The same result, therefore, can be obtained more easily by the addition of about 2 per cent of concentrated hydrochloric acid to the dichlorhydrin. If used within a short time of mixing, the product behaves in a similar manner to that activated by the original method. On storage, the activity increases still further, but does not approach that of the Carr – Price reaction. On the other hand, the stored reagent loses the very desirable property of stability of the chromophor, which develops and fades in much the same way as with the Carr – Price reagent.

It appears, therefore, that the reagent can be made sufficiently sensitive to replace the Carr – Price reagent only at the expense of the advantage which it claims over it, namely, stability of the chromophor.

D. D. Penketh

Research Department,
Lever Brothers and Unilever, Ltd.,
Port Sunlight, Cheshire.
Feb. 18.

[1] Sobel, A. E., and Werbin, H., *J. Biol. Chem.*, **159**, 681 (1945); *Ind. Eng. Chem.* (*Anal. Ed.*), **18**, 570 (1946); *Anal. Chem.*, **19**, 107 (1947).

Pressor Effect of Renin on Pulmonary Artery Pressure

In 1940 Katz and Steinitz[1] reported that following the production of hypertension in dogs by means of an experimental renal ischæmia, no change was observed in pulmonary arterial pressure. These workers used a modified London cannula technique so that observations could be made without anæsthesia in the intact animal. Using a similar method, Friedberg, Katz and Steinitz[2] found an increase in pulmonary arterial pressure in the dog after the injection of renin. They concluded that this was not due to a vasoconstrictor effect on the pulmonary bed, but to a reflexion of the change in systemic blood pressure through back pressure on the pulmonary circuit. We have confirmed the pressor effect of renin on the pulmonary artery pressure but are at variance with the opinion of the previous workers as to its causation.

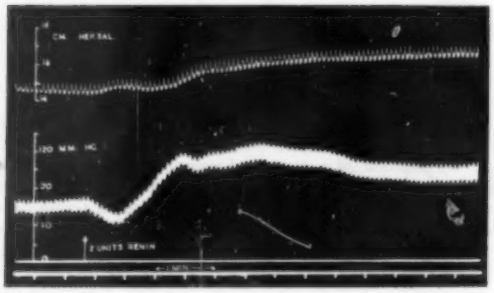
Renin was prepared from rabbits' kidneys by a modification of the method of Helmer and Page[3], and a study made of its effects on pulmonary artery pressure in dogs, a simultaneous record of femoral artery pressure being taken. Renin was injected into the femoral vein. Femoral artery pressure was observed by cannalization of the artery, a mercury manometer recording on a kymograph.

Pulmonary artery pressure was recorded by tying a *T* cannula, connected with a heparin-saline manometer, into the pulmonary artery extra-pericardially. Lateral pressure was therefore recorded in continuity. Such a procedure necessitated thoracotomy, performed by sub-periosteal resection of the sixth rib. Observations have been made with an open chest under pump respiration.

In all cases a rise in pulmonary artery pressure was observed. In the particular record shown, the initial blood pressure is rather low, in that it was taken from an animal on which a pneumonectomy had previously been performed, in the course of other work by one of us. Two units of renin, assayed on a 2-kgm. cat, were injected.

Both systemic and pulmonary artery pressures rose, the systemic reaching a peak in 2½ min., the pulmonary artery in 6½ min. Each pressor effect was sustained for 13 min. These figures apply to the particular experiment of which a portion of the record is shown, but similar durations were found in all cases. Before the pressor effect, the ratio between systemic and pulmonary artery pressures was 6 : 1, during the effect 10 : 1. Therefore the rise in pulmonary artery pressure was absolutely and relatively much less than the rise in systemic arterial pressure, although the durations of the two were similar. The slight initial rise in pulmonary artery pressure is due to the transient increase in venous return to the right heart occasioned by the injection of 2 ml. renin and 2 ml. saline wash.

While agreeing with the findings of Friedberg, Katz and Steinitz that the injection of renin produces a rise in the pulmonary artery pressure, our findings as to the details of this pressor effect differ from those of these authors, in that they found a greater percentage increase in pulmonary artery pressure than in systemic arterial pressure, which former rise was of shorter duration.



The pressor effect on the pulmonary artery pressure as described and illustrated in the figure is presumably due to one of, or a combination of, three causes: (*a*) bronchiolar constriction produced by renin; (*b*) a back pressure effect from the rise in systemic arterial pressure; (*c*) direct vaso-constriction, by renin, of the arterioles of the pulmonary circuit.

Further analysis of the cause of the effect is proceeding.

E. G. Brewin
R. A. Kenney
D. H. Miller

Department of Physiology,
School of Medicine,
Leeds 2.
Feb. 23.

[1] Katz and Steinitz, *Amer. J. Physiol.*, **128**, 433 (1940).
[2] Friedberg, Katz and Steinitz, *J. Pharm. and Exp. Therap.*, **77**, 80 (1943).
[3] Helmer and Page, *J. Biol. Chem.*, **127**, 757 (1939).

A Culture Method for *Lymnæa truncatula*

The amphibious snail *Lymnæa truncatula*, which serves as an intermediate host of the liver fluke, *Fasciola hepatica*, has been found in the past to be somewhat difficult to maintain in laboratory culture. In connexion with current work on the epidemiology of the severe disease of grazing animals which is caused by this parasite, one of our first problems was to establish satisfactory means of culturing the snail. Our attempts have proved so far successful that we are able to grow the snails in unlimited numbers, at different seasons of the year and to a larger size than they usually attain in their natural habitat.

On account of the particular interest of this mollusc and its association with *Fasciola hepatica* in the teaching of biology, as well as for the benefit of research workers in the field of parasitology, we felt that a description of the culture method might be of interest and value.

Having met with little success by aquatic culture methods, we proceeded with an attempt to reproduce in glass and earthenware vessels the natural habitat of the snail. This habitat comprises the small open mud flats that lie between pools of shallow water and low grassland. Finally, we developed the following technique. Unglazed earthenware pans, without holes in the bottom, 12–18 in. in diameter, of the kind used by nursery men serve as containers for the mud. Before use the pans are soaked for some days in pond water, then they are dried and coated, on the outer surface only, with paraffin wax, in order to prevent undue loss of water by evaporation. The mud which is to form the substratum of the culture is mixed with pond water in such proportions as to give it a wet plastic consistency. It is then sterilized by heat to destroy unwanted trematode infection and is placed in each pan in such a way as to form an even slope extending from near the upper lip on the one side to the floor of the pan on the other side. Depressions are made on the surface of the slope in several places, simulating on a small scale the footprints of animals, and sufficient pond water is poured over the surface of the mud to form a small pool at the bottom of the slope. The pan is then covered by a piece of glass and placed in a greenhouse where there is abundant light, to encourage the growth of algæ, and heat adequate for rapid development of the snails.

In two or three weeks the mud becomes covered with a thick growth of algæ and is then ready for the introduction of the snails. A light sprinkling of a mixture of equal parts of finely powdered natural chalk and fine oatmeal flour is applied to the surface of the mud at weekly intervals. This supplement to algal food, along with the addition of distilled water which is poured over the surface of the mud to make up for slight loss by evaporation, is all that is needed for the maintenance of the culture. It is important that the water and the mud should be of the most suitable kind for the culture of this snail, and it has been our practice to collect the mud from a heavy clay soil on which the snails are found to thrive particularly well in the natural state. The water used in the first preparation of the mud slope and for the first pool in the culture dish is also collected from this natural habitat. The sterilization of the mud is only carried out to eliminate unwanted fluke infection for the purpose of our particular work, and might not be necessary for ordinary purposes.

Our experience has revealed a much more rapid rate of multiplication of this snail than we had anticipated, and maintenance of a culture in such a simple matter that there would appear to be every reason for developing its use in the teaching of biology for demonstrating the life-history of a trematode.

E. L. Taylor
Alan Mozley

Ministry of Agriculture and
Agricultural Research Council,
Veterinary Laboratory,
Weybridge.
Feb. 23.

Resistance to 'Inanition' in Grass Seedlings

Resistance to 'inanition' in the early seedling stage of various species of herbage grasses when grown in competition with older established plants has been reported by Chippindale[1,2]. Recent observations on perennial ryegrass (*Lolium perenne* L.) suggest that a similar resistance occurs in larger seedlings, nine to ten weeks old, both in competition with plants of the same age and species, and also

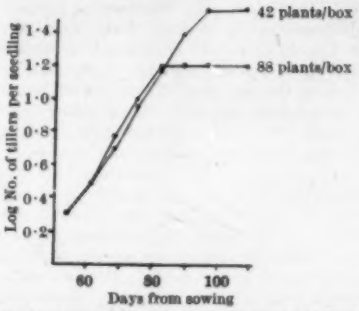


Fig. 1. Modal seedlings from box populations of different densities. Sown Jan. 20, 1947

when grown as single individuals with a limited root range and supply of soil nutrients.

In seedling studies on perennial ryegrass, attempts were made to obtain standard measurements of growth, which, unlike the usual dry-weight determination, did not involve destruction of the seedling, and could thus be traced throughout the life of the plant. Tiller number per seedling proved to be one of the most useful of these measurements, being highly correlated with dry weight, a typical box population giving $r = +0{\cdot}7416$, $n = 41$, $P < 0{\cdot}001$. For these experiments, any tiller visible above its subtending leaf-sheath was given unit value.

During early seedling growth, tiller number increases exponentially with time for each plant (Figs. 1 and 2), the exponential rate of tiller production decreasing with decrease in temperature, until below 38–40° F. no tillering occurs. For any one set of environmental conditions, this rate of tiller production is similar in all seedlings of a population, high or low tiller counts being the result of early or late initiation of tillering (Fig. 2). There is a highly significant correlation between tiller number and rate of leaf production in the initial stages of seedling growth, as would be expected since the tiller arises as a bud in the leaf axil. A typical example gives $r = +0{\cdot}6350$, $n = 35$, $P < 0{\cdot}001$.

When seedlings are grown with limited root range and soil nutrients, either in a box population or individually in small paper pots, after a time the initial exponential growth is sharply curtailed. Tillering ceases and leaf production is greatly reduced and may stop completely. This situation presumably corresponds to the 'inanition' observed in very young seedlings.

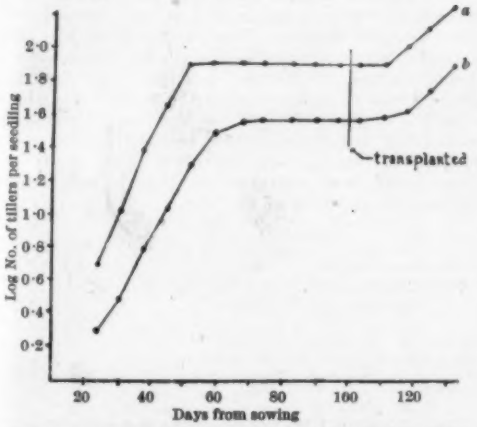


Fig. 2. Earliest (*a*) and latest (*b*) tillering seedlings from individual pots. Sown June 29, 1947

Fig. 1 shows the increase in tiller number with time, for modal single plants from box sowings of Irish commercial ryegrass, at seedling densities of 42 and 88 plants per box. This gives an average root space per plant of 259 and 124 c.c. respectively. There is no difference in the exponential rates of tillering in the two boxes, but tillering ceases much sooner with the denser spacing. These seedlings were transplanted to the field 110 days after sowing and quickly began to tiller vigorously. In these box sowings there was no competition for soil moisture, water being supplied regularly. The other possible limiting factors were competition for light, root interaction, and competition for soil nutrients. To eliminate the effects of root interaction and competition for light, seedlings from the same sample were grown individually in small paper pots of cubic capacity 195 c.c. Fig. 2 shows the increase of tiller number with time, for the earliest and latest plant to begin tillering. There is again no great difference in the initial rates of tillering, and for each plant, tiller production suddenly ceases, presumably when the soil nutrients in the pot have become exhausted. In general, seedlings which begin tillering earlier reach a higher limiting tiller number, even in the absence of inter-plant competition, and also attain their limiting size earlier.

When tillering had ceased in all these seedlings, each was transplanted to a larger pot (2,025 c.c.), thus giving a further supply of soil nutrients. In each case, tillering recommenced after a short interval and proceeded exponentially. By the time growth started again, the most highly tillered seedling had remained in a state of 'inanition' for 60 days, without any apparent dying-back of any of the tillers.

These observations, although confined to perennial ryegrass, do suggest that this resistance to 'inanition' caused by lack of soil nutrients may be an important factor, not only in initial establishment, but also in subsequent competition in the sward.

J. P. Cooper

Welsh Plant Breeding Station,
University College of Wales,
Aberystwyth.
Feb. 17.

[1] Chippindale, H. G., *Ann. Appl. Biol.*, **19**, 221 (1932).
[2] Chippindale, H. G., *Nature*, **161**, 65 (1948).

Occurrence of Volcanic Bomb in the Agglomeratic Slates of Kashmir

The specimen of volcanic bomb described here was collected in June 1946 by Mr. S. R. N. Rao, reader in geology, University of Lucknow, from a ridge near the village of Bren (lat. 34° 6½′ N., long. 74° 52¾′ E.) about 5½ miles north of Srinagar. It comes from the formation known as the Agglomeratic Slates, which form the lower part of the Panjal Volcanic Series. They are gritty or greywacke-like, and often grade into slates. In the fine matrix, angular fragments of quartzite, slate, porphyry, granite, etc., are distributed at random. The Agglomeratic Slates of Bren contain Lower Gondwana plants, associated with a series of

sandstones and shales containing a marine brachiopod fauna[1] and *Eurydesma*.

Two views were put forward by Middlemiss[2] for explaining the origin of the Agglomeratic Slates of Kashmir: (1) that these rocks were a product of explosive volcanic activity and sub-aerial deposition; (2) that the deposit resulted from frost action under glacial conditions, the frost-weathered matter being transported to lakes through the agency of floating ice. Wadia[3], after a detailed study of the rocks, favours a pyroclastic origin for the Agglomeratic Slates.

VOLCANIC BOMB FROM BREN SPUR NEAR SRINAGAR, KASHMIR. 3/5 NATURAL SIZE

Our specimen appears to be the broken half of an ellipsoidal volcanic bomb. It measures 5·7 in. along the longer axis and 2·3 in. along the shorter. The structure is clearly revealed by the broken surface. There is an outer crust, of an average thickness of about $\frac{1}{4}$ in., enveloping a core of typically vesicular rock. The crust is compact, slightly earthy and greenish-yellow in colour. The core is yellowish-brown, with cavities which are elliptical or triangular in shape and aligned parallel to the length of the bomb. If the bomb had been completely preserved, its thickness through the centre would have been about 3·6 in. The outermost portion of the crust appears to have been of a deep brown colour. A small patch of this colour, about 4 mm. in thickness, can still be seen on one side.

A detailed petrological study reveals that the rock of the volcanic bomb is felso-andesite.

The discovery of a volcanic bomb in the Panjal Agglomeratic Slates proves beyond doubt that these rocks are due to explosive volcanic activity.

I am obliged to Mr. Rao and Dr. P. K. Ghosh, of the Geological Survey of India, for confirming my observations.

R. C. MISRA

Department of Botany and Geology,
University of Lucknow.

[1] Reed, F. R. C., *Pal. Ind.*, New Ser., **20**, Mem. No. 1, Plate XIII (1932).
[2] Middlemiss, C. S., *Rec. Geol. Surv. Ind.*, **40**, 233 (1910).
[3] Wadia, D. N., *Mem. Geol. Surv. Ind.*, **51**, Pt. 2, 236 (1928).

Proposed Central Publication of Scientific Papers

MANY of the problems of scientific publication that will be considered at the forthcoming Scientific Information Conference called by the Royal Society of London for June[1] could be solved by use of the method of auxiliary publication that has been in use in the United States since 1936[2,3].

Auxiliary publication on demand does not interfere with the free and normal channels of scientific publication. The benefits of the central distribution of scientific papers proposed by Bernal can be obtained without the dangers of centralized control set forth by Sir George Thomson and Dr. J. R. Baker[4].

Some three thousand scientific papers, called 'documents', are on deposit with the auxiliary publication service of the American Documentation Institute at Washington, D.C., and additional material is being deposited constantly. A catalogue of such ADI Auxiliary Publications is available[5]. Primarily, the existence of the 'document' and its availability on order is notified to scientific men and others by publication of notices in the journals whose editors transmit the documents for deposit. 'Documents' are noted in abstract journals in the same manner as other articles. Those who desire a 'document' order it and receive it in microfilm or photoprint form.

The auxiliary publication plan has been adopted by such large-scale literature distribution operations as that of the Office of Technical Services of the U.S. Department of Commerce, which has on file more than five million pages of material, largely technical German documents, which it distributes in this manner. In the world organisation of scientific literature, it would be desirable to co-ordinate and provide interchange between auxiliary publication centres when they are established in various countries or geographical regions.

The detailed operation of auxiliary publication, applicable to original publications, translations, reference material, illustrations and tables alike, is as follows.

The editor of a journal can publish as much or as little of a technical paper as he wishes. In the case of a very specialized paper, it may be only an abstract or summary. He appends to the notice or article a note saying that the full article with diagrams, pictures, etc., can be obtained by remitting a certain price and specifying the document number under which this full article has been deposited at the central agency operating the auxiliary publication service. Orders are sent by readers directly to this central agency, which is the American Documentation Institute at Washington, D.C. Microfilms of the 'document' or, when desired, enlarged photoprints readable without optical aid are made only if and when ordered. In this way the 'document' is perpetually 'in print' but no extensive, space-consuming stocks need be stored—only the 'document' itself and the microfilm negative from which positives are made for distribution. The operation of the plan is simple and uncomplicated, and editors may use it when, how, and if they find it helpful. No financial participation or guarantees on the part of the editor or author are required. While the plan of auxiliary publication suggested could be used with other methods of duplication, microfilm is the least expensive and most universal, in that it will handle text and illustration of any sort.

WATSON DAVIS

Science Service,
Washington, D.C.
May 19.

[1] *Nature*, **161**, 469 (1948).
[2] Davis, Watson, *Science*, **83**, 402 (1936).
[3] Bernal, J. D., "The Social Function of Science", 455, Appendix VIII (1939).
[4] *Nature*, **161**, 772 (1948).
[5] Catalog of Auxiliary Publications in Microfilms and Photoprints, American Documentation Institute, Washington, D.C. (1946). Free on request.

MESONS AND NUCLEONS

By Prof. O. KLEIN
Institut för Mekanik och Matematisk Fysik, Stockholms Högskolas

I SHOULD like to direct attention to an approach to the problem of the relation between mesons and nucleons, which, although speculative, seems to give a reasonable account of the main features of our present knowledge, including the fundamental work recently carried out at Bristol. The main assumptions, some of which have already been discussed by other physicists, are given below. We use the nomenclature employed by the Bristol observers for the different categories of mesons observed in photographic plates.

(1) The ordinary cosmic-ray meson (μ-meson), and its neutral counterpart, are particles of spin $\hbar/2$ with Fermi statistics. The decay of a charged meson is a true β-process, giving rise to a neutral meson, an electron and a neutrino.

(2) These particles interact by means of a Yukawa field corresponding to positively and negatively charged particles of integral spin, Bose statistics, and masses of mesonic order of magnitude. There being only charged particles of this kind, interactions of pair type will be essential. The role of these particles, and their properties, being similar to those of the photons, we may perhaps call them 'electro-photons', reserving the name meson for the particles mentioned in (1). Some σ-mesons may be of this kind, and they may be expected to occur in penetrating showers.

(3) π-Mesons, and possibly other mesonic particles of still higher mass[1], are supposed to be metastable compound systems of mesons, held together by means of the interaction mentioned above. Moreover, as a working hypothesis, we shall assume the nucleons themselves to be stable compound systems of mesons.

Having stated them, we shall now attempt a brief discussion of the arguments in favour of these assumptions, and the difficulties which they raise. Thus, in the first place, we encounter a well-known feature of any relativistic theory: the difficulty of forming a compound system with dimensions smaller than the Compton wave-length of the constituent particles. In the present instance, this length is of the same order of magnitude as the range of the forces. Dr. N. Hu has kindly pointed out to me that this difficulty is much more pronounced in an s-state than in one where the particle has an angular momentum. This may mean that a stable compound system contains only one particle in an s-state—two such particles involving a great increase in the strength of the field in which each of them moves—and, in addition, as many particles in states with an angular momentum, as is required to make the binding energy per particle as high as possible. Without a more developed theory of the interaction, it is, of course, difficult to predict how large the number of particles will be, but making use of the actual mass values of the particles in question, we may, hypothetically, regard a neutron as being built up of seventeen neutral mesons. We may assume that these particles form complete p-groups (six particles), d-groups (ten particles), and a single particle in an s-state. Of course, this classification of the separate particles according to their angular momentum is only valid in the Hartree approximation; nevertheless, it would seem to be a sufficient approximation in the present case. In order to balance the very high kinetic energy of these particles, contained in a volume of the order of magnitude $(\hbar/\mu c)^3$, where μ is a mass of mesonic order of magnitude, the forces must, of course, be much stronger than those occurring between the nucleons in the atomic nuclei. Since, however, in most nuclear force theories, a 'cut-off' procedure is applied at a distance comparable with the range of the forces, this may not require any particularly high value of the interaction constant g, but only a less violent 'cut-off'.

Suppose now that the rest mass, m_ν, of the neutral meson is $120\,m_e$, m_e being the electron rest-mass, a value which seems to be consistent with the conclusions of the Bristol workers. In fact, the values $m_\nu = 120\ m_e$, m_μ (mass of ordinary charged meson) $= 220\,m_e$, and m_π (mass of π-meson) $= 365\,m_e$, would correspond to a kinetic energy of the decay meson in the Bristol experiments of 4·4 MeV., and a ratio $m_\pi/m_\mu = 1{\cdot}66$. Comparing the value $17 \times 120\,m_e$ with the mass of the neutron, $1839\,m_e$, we obtain a binding of 100 MeV. for the neutron, a value which seems not unreasonable in view of the recent Berkeley experiments, which may perhaps be taken as an indication that nucleons can be broken up in collisions at an energy of some hundred MeV.

Since, according to the above assumptions, the decay of the ordinary meson is, so to speak, the prototype of all β-processes, it is important that the value of the life-time, $\tau = 2 \times 10^{-6}$ sec., and the energy available in the process $\sim 100\,m_e c^2$, fit in very well with the value to be expected from our knowledge of the β-decay. Let ε be the energy available divided by $m_e c^2$, and $F(\varepsilon)$ the well-known Fermi function, which for large ε-values may be taken as $\varepsilon^5/50$. We then obtain for the product $\tau . F(\varepsilon)$—putting $\tau = 2 \times 10^{-6}$ sec. and $\varepsilon = 100$—the value 667, which is of about the expected magnitude. The value $\varepsilon = 100$ would also seem to be consistent with the energy values indicated by the small number of cloud-chamber pictures of decaying mesons. (The above considerations were essentially stimulated by a communication kindly made to me by Prof. J. Blaton in connexion with an interesting attempt to regard the π-meson as a compound system of a neutral and a charged meson. In this approach, the component particles were supposed to be of integral spin, and kept together by forces of the original Fermi type, corresponding to an interaction by means of electron-neutrino pairs. It was then found that the interaction constant corresponding to the meson life-time is of the same order of magnitude as that to be expected from Fermi's original theory of β-disintegration, a result which is, of course, identical with that of the above calculation; see also Konopinski[4].)

Proceeding now to the proton, we shall again assume a system of seventeen particles, but with a unit charge. Owing to the strong interaction with the Yukawa field, this charge would probably belong to the whole system rather than to any individual meson. Keeping in mind that the charged meson is about $100\ m_e$ heavier than the neutral meson, the question arises how this difference can be more than compensated in the compound system, so as to give the observed difference in mass of the proton and the neutron. A possible explanation may be that the interaction corresponding to an exchange of a single electrophoton, in the interaction between unlike particles, has to be added to the pair interaction in the case of like particles. An estimate of the constant g of this interaction, required to compensate the

mass difference in question, is seen to give a very reasonable value of the order of magnitude of the electronic charge. In fact, since the size of a nucleon is probably of the order of magnitude of, or even smaller than, the range of the forces in question, we may estimate this effect by considering the decrease of potential energy of a sphere of N particles each of electric charge g, to which a particle of charge $-g$ is added. This, now, will be equal to $\frac{3}{5} \cdot \frac{(2N+1)}{a} g^2$, if a is the radius of the sphere. With $N = 16$, we obtain thus the following approximate relation

$$\frac{3}{5} \cdot \frac{33g^2}{a} \simeq 100\, m_e c^2 = 100\, \frac{e^2}{a_0},$$

where a_0 is the radius to the electron; or, $g^2 \simeq 5\, \frac{a}{a_0}\, e^2$. From the well-known sizes of atomic nuclei, we get, as an upper limit to the value, $1{\cdot}2 \times 10^{-13}$ cm.; while $a_0 = 2{\cdot}8 \times 10^{-13}$ cm.; and thus $g^2 \leq 2e^2$.

The problem of the capture by nuclei would, of course, be a rather different one for the mesons and for the electrophotons. The latter particles would probably behave in accordance with the theories developed along the lines of Yukawa's original ideas, mesons taking now the role of nucleons. On the other hand, the former particles may either be captured in a way somewhat analogous to the K-capture (similar to suggestions put forward by Pontecorvo and Weisskopf[2]), with the emission of a neutral meson and a neutrino pair; or in an annihilation process of the Dirac type. As Dr. B. Bruno has kindly pointed out to me, this latter process will have a considerable probability, a point to which he hopes to return in connexion with a study of the problem of meson capture.

As to the Yukawa particles or electrophotons, their relation with the meson being similar to that of mesons and nucleons in the current meson theories, we should expect to observe their creation by *Bremsstrahlung*—in processes, for example, such as the impact between fast nucleons or mesons. Moreover, we should expect that mesons could be created in pairs by electrophotons as well as by photons of high energy, a phenomenon which may, perhaps, play a part in the penetrating showers. On the other hand, collisions between fast particles and nuclei may lead to the break-up of nucleons, whereby metastable compound systems like the π-meson may be formed. In such processes we should expect an excess of positive particles, although negative particles of this kind are perhaps not excluded, owing to the strong interaction of the mesons with the electrophotons. Nevertheless, we should expect the positive and negative mesons, like positrons and electrons, to be separated by an energy gap equal to twice the rest-mass energy. Just as the ordinary neutron is closely connected with the positive proton only, we should expect that there would be two kinds of neutral mesons, connected with the positive and the negative mesons respectively, which would probably have magnetic moments of opposite sense relative to the spin.

As regards the problem of the interaction of nucleons, the above considerations would imply some modifications of the theory by the introduction of a natural radius of a nucleon; that is, a strong repulsion when the distance between the nucleons gets below a certain value, $\simeq 10^{-13}$ cm. This may have some consequence for the scattering problem, as well as for the problem of the saturation of nuclear forces. Further, if a nucleon is a compound system of some seventeen particles, the value of the interaction constant for the force between two nucleons will have a less fundamental significance than in the ordinary meson field theory. Since the Yukawa theory of β-radioactivity would have to be applied to the mesons interacting with electrophotons, we shall expect the life-time of the latter particles to be considerably shorter than that of the mesons, which may account for the lack of evidence for the existence of these particles. It would perhaps be worth while, however, to consider the possibility that the large spread of the mass values obtained for the cosmic ray mesons may be partly due to some of the measured particles being electrophotons. In an attempt to regard the nuclear field force theory as a generalization of the relativistic field theory of electromagnetism and gravitation, I obtained the following expression for the rest mass μ_e of a charged Dirac particle, as compared with the rest mass of the corresponding neutral particle μ_n:

$$\mu_e = \sqrt{\mu_n^2 + \mu^2},$$

where μ is the mass of the electrophoton[3]. Apart from the ambiguity still present in the basic assumptions, this formula neglects possible self-energy effects on the masses of the particles. Still, it is interesting that, with the above values for μ_e and μ_n, it gives a reasonable value for μ, namely, 185 m_e.

According to the view developed here, the building up, as well as the destruction in any appreciable amount, of nucleons would require conditions differing even more from those prevailing in the known parts of the universe than those necessary for the building up and destruction of nuclei. Thus an equilibrium in which there is a considerable dissociation of nucleons into mesons would seem to require a temperature corresponding, at least, to $kT \simeq 100$ MeV. At this temperature, the mass density of meson pairs, as calculated from the ordinary Fermi distribution formula, would approach that in the interior of an atomic nucleus.

In concluding these remarks, it may be stressed that owing to the strong assumed interaction between mesons and electrophotons, and the size of the Compton wave-length as compared with the range of the forces, we are at the extreme limit of the region where it is permissible to speak about systems built up of individual particles. Although this would suggest that great caution should be observed in the handling of the problem, it would not seem, *a priori*, to make fruitless an attempt such as that under consideration.

Note added to proof. Since the above was written, definite evidence has appeared in favour of a mass value $\sim 300\, m_e$ for the σ-mesons; their production in the Berkeley experiments and their star-producing capacity making it, moreover, very probable that they are the true Yukawa particles or electrophotons. Their assumed identity with the π-mesons, which, if correct, would necessitate important alterations of the hypothetical postulates put forward in the above note, seems to me less evident, however; and it is perhaps not out of place to discuss the consequences of the opposite assumption in the light of the new results.

Thus it would seem natural to assume the mass m_σ of the σ-meson to be smaller than $m_\pi + m_\mu$, the sum of the masses of the two μ-mesons, charged and neutral; while m_π, the mass of the π-meson, would

have to be greater than $m_\nu + m_\mu$. Using the values of the above example, we should have $m_\pi > 340\, m_e > m_\mu$, an inequality which does not seem contradictory to present experience. While on this assumption the σ-meson could not spontaneously give rise to a pair of μ-mesons (charged and neutral), such a process would be possible in the field of a nucleus, if the energy is sufficient—as it might easily be under the Berkeley conditions. It is suggested that this may be the explanation of the comparatively large number of μ-mesons observed in the Berkeley plates. While the most probable process under those conditions seems to be the formation of σ-mesons by *Bremsstrahlung*, the observed cases of π-decay might on the above view be due to a break-up of nucleons, a process which would be expected to occur with measurable probability, the energy quantum (frequency multiplied by Planck's constant), corresponding to the collision time, being of the same order of magnitude as the assumed binding energy of the nucleon.

Without entering more closely on the consequences of the opposite assumptions—the identity of σ- and π-mesons—for the above considerations, I should like to state that in my view the interpretation of the μ-meson as an $\hbar/2$-particle with an ordinary β-decay, which is, of course, independent of the hypothesis concerning nucleons and π-mesons, has not only a better foundation than the other assumptions of the above note, but also the more important bearing on the problem of the incorporation of meson theory in the general relativistic field theory. In this connexion it should perhaps be mentioned that the argument given in the note concerning the mass value of the electrophoton can only be expected to give the order of magnitude.

[1] Leprince-Ringuet, L., and L'Héritier, M., *J. Phys. Radium*, (8), **7**, 66, 69 (1946). Rochester, G. D., and Butler, C. C., *Nature*, **160**, 855 (1947).

[2] Weisskopf, V., *Phys. Rev.*, **72**, 155 (1947). Pontecorvo, B., *Phys. Rev.*, **72**, 246 (1947).

[3] Klein, O., *Ark. and Mat. Astr. O. Fys.*, **34** A, No. 1 (1946).

[4] Konopinski, *Rev. Mod. Phys.*, **15**, 207 (1943).

EXCITATION CURVES FOR THE γ-RADIATION FROM LIGHT ELEMENTS BOMBARDED WITH α-PARTICLES FROM POLONIUM

By PROF. HILDING SLÄTIS

Nobel Institute for Physics, Stockholm

A LARGE number of investigations have been carried out on the disintegration of light nuclei bombarded with α-particles. In several cases excitation curves have been obtained for the γ-radiation as a function of the energy of the α-particles. (A review of earlier polonium α-particle bombardments of light elements, particularly those which may be of interest for a possible γ-radiation, has been published by the present writer in *Arkiv. Mat., Ast. Fysik*, **35** A, No. 31; 1948). The results of different authors, however, are often inconsistent. For that reason I made use of an available polonium sample of about 40 mC. for observing the excitation functions of the γ-radiation from light elements bombarded with α-particles. The energy of the α-particles was varied by means of carbon dioxide.

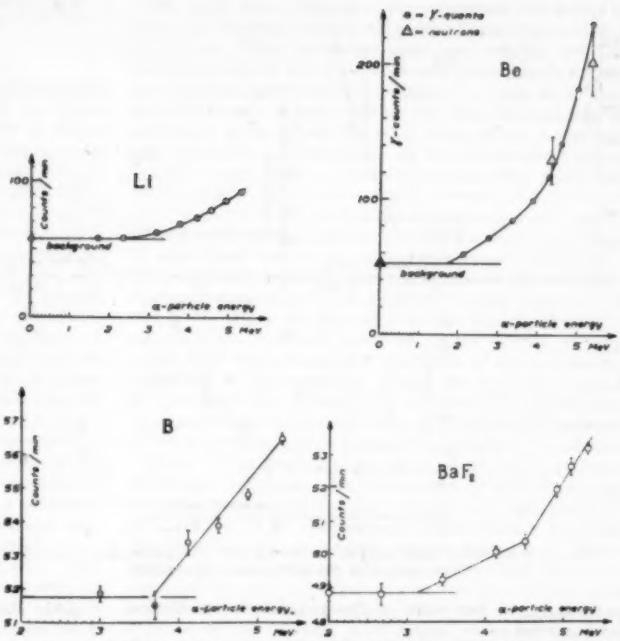


FIG. 1. EMISSION OF γ-QUANTA (○) FROM LITHIUM, BERYLLIUM, BORON, FLUORINE, AND NEUTRONS (△) FROM BERYLLIUM AS A FUNCTION OF THE ENERGY OF THE BOMBARDING α-PARTICLES

Lithium, beryllium, boron, carbon, nitrogen, oxygen, fluorine, sodium, magnesium, aluminium, silicon, phosphorus, sulphur, chlorine, potassium, calcium and lead were investigated. γ-Emission was observed from lithium, beryllium, boron, nitrogen, fluorine, sodium, magnesium and aluminium. The intensity of the γ-radiation was measured as a function of the energy of the α-particles for all these except nitrogen (Figs. 1–2). The α-particle threshold values for γ-emission and the relative intensities (as percentage of the measured polonium γ-radiation background) of the γ-quanta are given in the accompanying table.

Element	γ-Emission starts at the α-energy	Intensity of the γ-radiation for 5·3 MeV. α-particles
	MeV.	
Li	2·3	61
Be	1·7	340
B	3·7	9·0
N	—	2·7
F	3·1 (and 4·5)	9·0
Na	4·6	9·5
Mg	3·6	3·7
Al	4·1	7·9

The statistical errors are represented in all the diagrams except the γ-emission curves for lithium and beryllium, where the errors were too small to be

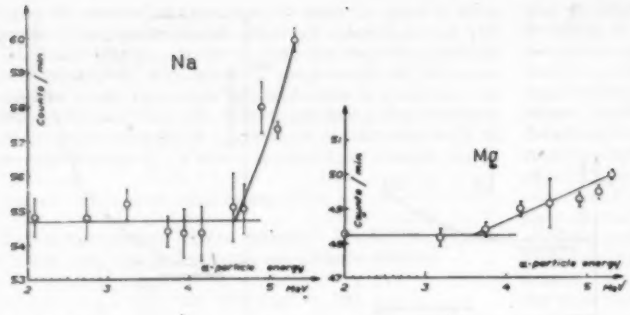


Fig. 2. γ-EMISSION FROM SODIUM, MAGNESIUM AND ALUMINIUM AS A FUNCTION OF THE ENERGY OF THE BOMBARDING α-PARTICLES

plotted ($\lesssim$ 1 per cent of the polonium γ-radiation background).

The neutron-emission from beryllium was measured for α-particles of energies 4·3 and 5·3 MeV. The results and the statistical errors are plotted on an arbitrary scale in Fig. 1.

$_3$**Li.** The γ-radiation is due to an excitation of the Li^7-nucleus by inelastic collisions with α-particles, as quoted, for example, in the paper by Siegbahn and Slätis[1]. The γ-radiation starts for α-particles of the energy 2·3 MeV., in agreement with the result of Schnetzler[2] but not with earlier investigations by Webster[3] (1·9 MeV.), Curie and Joliot[4] (3·1), Savel[5] (2·8–3·0).

$_4$**Be.** The γ-radiation maximum with 2·7 MeV. α-particles found by Becker and Bothe[6] could not be confirmed, nor the starting point of the γ-emission for α-particles of the range 1·7 cm. (3 MeV.). The neutrons seem to be emitted simultaneously with the γ-quanta, as predicted by Chadwick[7]. The energy (1·7 MeV.) of the α-particles at which the γ-emission starts is the same as Chadwick found for the beginning of the neutron emission, and is in fairly good agreement with the starting points for the γ-emission found by Webster[3] (1·9 MeV.) and by Szalay and Zimonyi[8] (1·62 MeV.). Rasetti[9] found 1·6 MeV. for the beginning of neutron emission and Curie and Joliot[4] 1·3 MeV. for neutrons and γ-quanta.

$_5$**B.** According to Becker and Bothe[6], the γ-radiation begins at the same α-particle energy for which the second proton group starts (also in agreement with v. Baeyer[10]). The corresponding α-particle range was 2·90 cm. (4·4 MeV.). This is not in agreement with the curve in Fig. 1, which starts at 3·7 MeV., or with the results of Webster[3] (1·9 MeV.), or those of Szalay and Zimonyi[8] (1·5 cm. = 2·7 MeV.), but in good accordance with Heidenreich[11] (3·6 MeV.) and Alichanow, Alichanian and Dzelepow[12] (2·1 cm. = 3·5 MeV.).

$_9$**F.** The first proton *pair* found by Chadwick and Constable[13] started at an α-range of 2·2 cm. (3·64 MeV.), the second pair at 2·7 cm. (4·2 MeV.). This result is not in agreement with my observations; I find that (Fig. 1) the γ-radiation starts at 3·1 MeV. with clearly a second component at 4·5 MeV. energy of the α-particles. The starting point 0·9–1·2 MeV., found by Savel[5], seems to be very improbable. Speh[14] discovered that the γ-radiation consisted of two components. The harder one started at 3·1 cm. α-particle range (4·6 MeV.), which is in good agreement with the second starting point of the γ-radiation shown in Fig. 1.

$_{11}$**Na.** According to Fig. 2, γ-emission starts at an α-particle energy of 4·6 MeV. This agrees neither with Savel's[5] result (3·7–4 MeV.) nor with Kovács's[15] (2·7 MeV. and 3·5 MeV.). König[16], however, found a proton resonance group, called *B*, which started at 4·8 MeV. This is in accordance with my result.

$_{12}$**Mg.** Klarmann's[17] first proton group started at an α-particle energy of 3·26 MeV., which may agree with my value 3·6 MeV. for the beginning of the γ-radiation (Fig. 2). Savel[5] found 4·3–4·5 MeV.

$_{13}$**Al.** Pose's[18] first proton group for an α-range of 2·50 cm. (4 MeV.) agrees well with the α-particle threshold value 4·1 MeV. for the γ-emission found by me (Fig. 2). Chadwick and Constable[13] found for the first proton pair a threshold value 4·2 MeV. for the α-particle energy, also in good accordance with my result. Savel[5] found 3–3·3 MeV. for the beginning of the γ-emission, Fahlenbrach[19] 3 cm. (4·5 MeV.) for the starting point of the (α, p)-process, Alichanow, Alichanian and Dzelepow[12] 3·4 cm. (4·9 MeV.) for the (α, n)-process. For the same (α, n)-process Waring and Chang[20] obtained 3·4 MeV. Pollard, Schultz and Brubaker[21] found possible resonance effects at 2·3 cm. (3·8 MeV.) and 4·8 cm. (6 MeV.). The former α-particle energy 3·8 MeV., as well as Fünfer's[22] value 2·3 cm. (3·8 MeV.) and the starting point 2·4 cm. (3·9 MeV.) for the γ-radiation, found by Szalay and Zimonyi[8], agree well with my α-particle energy value 4·1 MeV. for the beginning of the γ-radiation from aluminium.

[1] Siegbahn, K., and Slätis, H., *Nature*, **160**, 471 (1947); *Arkiv. Mat., Ast. Fysik*, **34** A, No. 15 (1947).
[2] Schnetzler, K., *Z. Phys.*, **95**, 302 (1935).
[3] Webster, H. C., *Proc. Roy. Soc.*, A, **136**, 428 (1932).
[4] Curie, J., and Joliot, F., *C.R. Acad. Sci., Paris*, **196**, 397 (1933).
[5] Savel, P., *Ann. de Phys.*, **4**, 88 (1935).
[6] Becker, H., and Bothe, W., *Naturwiss.*, **20**, 349 (1932).
[7] Chadwick, J., *Proc. Roy. Soc.*, A, **142**, 1 (1933).
[8] Szalay, A., and Zimonyi, J., *Z. Phys.*, **115**, 639 (1940).
[9] Rasetti, *Z. Phys.*, **78**, 165 (1932).
[10] v. Baeyer, H. J., *Z. Phys.*, **95**, 417 (1935).
[11] Heidenreich, F., *Z. Phys.*, **86**, 675 (1933).
[12] Alichanow, A. I., Alichanian, A. I., and Dzelepow, B. S., *Z. Phys.*, **93**, 350 (1935).
[13] Chadwick, J., and Constable, J. E. R., *Proc. Roy. Soc.*, A, **135**, 48 (1932).
[14] Speh, K. C., *Phys. Rev.*, **50**, 689 (1936).
[15] Kovács, M., *Phys. Rev.*, **70**, 895 (1946).
[16] König, A., *Z. Phys.*, **90**, 197 (1934); *Naturwiss.*, **22**, 150 (1934).
[17] Klarmann, H., *Z. Phys.*, **87**, 411 (1934).
[18] Pose, H., *Phys. Z.*, **30**, 780 (1929); *Naturwiss.*, **17**, 624 (1929).
[19] Fahlenbrach, H., *Z. Phys.*, **94**, 607 (1935).
[20] Waring, I. R. S., and Chang, W. Y., *Proc. Roy. Soc.*, A, **157**, 652 (1936).
[21] Pollard, E., Schultz, H. L., and Brubaker, G., *Phys. Rev.*, **53**, 351 (1938).
[22] Fünfer, E., *Ann. de Phys.*, **32**, 313 (1938).

REACTIVITY AND STRUCTURE OF MOLECULES

AN International Colloquium on Isotope Exchange and Molecular Structure was held in Paris during April 5–12 under the presidency of Mme. Joliot-Curie. It had been organised, with the support of the Rockefeller Foundation, by three French scientific workers well known for their contributions to these subjects, R. Daudel, M. Haïssinsky and P. Süe. About a dozen speakers had been asked to read papers; others had been invited to contribute to the discussions. A somewhat unusual feature was the friendly insistence by the organisers on French as the only 'official' language; but as the Paris colleagues had taken the trouble of translating papers before the congress started, all foreign authors bravely presented them in the language of their hosts. During the discussions most of them preferred to express, or to hear, the arguments in their mother tongue; this caused no difficulty, as good linguists were always present and willing to act as interpreters. (One of the most competent translators sometimes even quietly amplified what had actually been said by a speaker.) A further help was the distribution of the manuscripts in their original tongue to all the participants.

The discussions were lively and inspiring; they will be printed in full, together with the addresses, in *Le Journal de Chimie et Physique*. We shall confine ourselves here to a brief summary of the papers.

Although the main subject of the colloquium was the connexion between the structure of a molecule and its ability to take part in isotopic exchange processes, several of the papers dealt only with questions either of structure, or of exchange, leaving the conclusions to be drawn to the discussion or to further investigations. A contribution to the subject in its strict sense was the opening address by Prof. L. Pauling (Pasadena) on "Structure of Complexes and the Influence of Structure on Exchange Reactions"; according to his calculations, the replacement of one group in a complex molecule by another may occur readily if the co-ordination number of the complex is smaller than the maximum permitted by steric considerations. To the same group belonged the papers by P. Süe and G. Kayas (Paris) on "The Behaviour of some perfect Cobalt Complexes in Szilard-Chalmers Reactions"; by B. Pullman, P. Rumpf and F. Kieffer (Paris) on "Isotopic Exchange Reactions and Electronic Structure of Substituted Aromatic Hydrocarbons"; and by C. K. Ingold (London) on "Isotope Exchange and the Mechanism of Heterolytic Substitution". A theoretical paper on "Free Valence in Organic Reactions" was read by Prof. C. A. Coulson (London).

Prof. C. D. Coryell (Boston, Mass.) discussed the results of studies carried out in the Clinton Laboratories on the valency states of the elements selenium, tellurium, bromine, iodine and cerium, if produced by nuclear transformations and present only in tracer concentrations; he pointed out that the results are not yet numerous enough to offer themselves for broad generalizations. It is likely that each element will show peculiarities which can only be explored by detailed studies. An example of such an investigation of a single case was given by P. Süe in his work on the ions formed in sodium arsenite, sodium arsenate and sodium cacodylate under the impact of neutrons; it seems that in these reactions the lower valency state is favoured.

M. and Mme. Daudel, in collaboration with S. May, R. Muxart and O. Chalvet (Paris), presented a paper on "The chemical reactions which are the consequences of those nuclear reactions which do not change the nature of the element". Such a nuclear reaction may consist either in the absorption of neutrons with emission of γ-rays, or in a nuclear isomerization; in the first case the observed chemical reactions are easy to foresee as following from the production of free, fast-moving atoms; the chemical effects of isomeric nuclear changes have to be interpreted by a mechanism involving the re-arrangement of the electrons in the atom concerned. E. Broda (Vienna) discussed the various methods available for the determination of the yield of nuclear reactions of the (α, n) type; he showed that the Szilard-Chalmers effect of the emitted neutrons offers certain advantages over the alternative methods of the ionization chamber or photographic plate. In a second paper he discussed the phenomenon of 'retention' of activity in cases where one would expect the Szilard Chalmers effect to give complete separation of the active atoms.

Two of the contributors dealt with heterogeneous exchange reactions. M. Haïssinsky (Paris) described experimental investigations carried out, together with M. Cottin and B. Varjadebian, on exchange between metal electrodes and their ions in solutions. Their object was to compare the exchange rates with the electrochemical potentials of the metals, taking into account also the possible effect of temperature, concentration, acidity, mechanical state of the surface, and all the other factors which may be of influence on exchange rates. The authors consider the imposing experimental material they have collected only as the beginning of further researches necessary for the full understanding of the exchange mechanism. In a second paper, M. Haïssinsky examined in a critical way the possible connexions between the exchange processes on the surface of the electrode and various electrochemical phenomena; he found that his experiments support Piontelli's distinction of two classes of metals. The other paper on heterogeneous exchange was read by F. A. Paneth (Durham). The exchange of ions between solution and crystal surfaces has, since 1923, often been used as a method for the determination of the extent of the surface area. In reviewing published and a few unpublished experiments, he has come to the conclusion that the exchanging part of the surface may be much smaller than the geometrical surface, but at the same time the only important one for the phenomena of adsorption and catalysis, and therefore well worth studying. This view was supported by Prof. M. Prettre (Lyon). Furthermore, the measurement of the equilibrium between ions in crystal surfaces and non-isotopic ions in solution may help to an understanding of the precipitation reactions of tracer elements without isotopic carriers.

The unfortunate absence of the authors did not diminish the interest taken in the papers by C. C. Evans and S. Sugden (London) on "Exchange Reactions and Electrolytic Dissociation", and by M. D. Kamen, J. W. Kennedy and O. E. Myers (St. Louis) on "Kinetic Studies on Isotopic Exchange Reactions" (both read by M. Haïssinsky), but naturally restricted the possibilities of a discussion.

At the end of the last session, before the concluding words of Mme. Joliot-Curie, Prof. G. v. Hevesy (Stockholm) summed up the proceedings by giving a brief résumé of all the contributions. During a break in the meetings the guests were given the opportunity

of visiting the Laboratoire de Physique Nucléaire under the guidance of its director, F. Joliot (who was also an occasional contributor to the discussions), and the French Government's Atomic Energy Establishment at Châtillon, where preparations are far advanced for the erection of a heavy water–uranium oxide plant, and an impressive array of counting equipment of all types is being produced. Châtillon is an old fort in the outer defence girdle of Paris, and the skill with which the dark subterranean rooms have been converted into modern laboratories deserves admiration.

The last day of the congress was free from lectures and offered good opportunities to continue some of the discussions in smaller circles before the final dispersal of the participants of a very successful international meeting.

F. A. PANETH

FAUNA AND FLORA OF PALESTINE

PALESTINE'S fast diminishing larger fauna is bound to suffer from the Jewish–Arab war; many species of great historic interest may be exterminated, and several, like the gazelle, the geographical races of which have not yet been fully worked out by the modern zoologists in the country, may be among them. Attention was directed to the serious reduction in the numbers of the larger mammals by modern 'hunters' in special surveys reported in the bulletins of the Jerusalem Naturalists' Club in 1946. The difficulty of human food supplies will be a serious threat to the remaining numbers of ibex already on the verge of extinction in the country; and the departure of the Palestine Police Force which alone enforced the British-made game laws—these prohibited the shooting of ibex, eagles, vultures, kestrels, owls, etc., and imposed certain close seasons and preserved certain forests against goat-grazing—will leave unrestricted the activities of 'hunters' and others. The grazing of these reserves by Beduin goatherds will have a serious effect upon plant life, for the ubiquitous goat is one of the most serious destroyers of flora in the country and a contributory factor to the costly menace of soil erosion.

Bab el Wad, which has been the scene of many recent news reports of a battle on the Jaffa–Jerusalem road, is a pine forest planted by the British authorities, twenty-four kilometres below Jerusalem. It consists mainly of *Pinus halepensis* and a large summer flora including *Varthemia*, *Centaurea cyanoides*, *Helichrysum sanguineum*, *Cistus vilosus*, *Acanthus syriacus* and many Labiates (Bull. 25, Jer. Nat. Club, p. 4), while W. F. W. Harding and E. Hardy collected and photographed in the forest the interesting amaryllid, *Pancratium parviflorum*, and *Narcissus Tazetta*, the Palestine iris, and various *Crocus*, *Cyclamen*, etc. (*J. Roy. Hort. Soc.*, **71**, 3; 1946).

The bird-life of Palestine, like the mammals, may see the most immediate threat since the removal of law and order to the larger birds of prey; but the netting of quail, suppressed by the British authorities, will probably be resumed for food, together with the unrestricted shooting of the many wildfowl that visit Lake Huleh and the Jordan Valley. The nightjar is among the birds recorded at Bab el Wad in Hardy's 1946 "Handlist of the Birds of Palestine", and this work pointed out that the great bustard, the Egyptian goose and the Syrian ostrich are already extinct in the country, and the white stork, the lammergeier, the imperial eagle and the white-faced duck no longer nest there.

Among the more immediate threats to bird-life in the present emergency will be that to the nesting colony of purple herons at Lake Huleh, the young of which are eaten as food by the Arabs. Other scarce birds likely to be sought to augment the food supplies are the houbara or Macqueen's bustard of the southern and Jordan deserts, which no longer nests in the country, the red-billed chukor partridge of the central hills and the Hey's sand partridge of the semi-deserts. Quail-catching and the shooting of songbirds for food will probably assume the large extent they already reach in Syria. The Hebrew University has shown an active interest in plant and bird conservation, and they and the Arab Scout movement and several private individuals were active supporters of the efforts made by the now defunct Jerusalem Naturalists' Club to conserve the rapidly diminishing fauna of the Holy Land during the last few years of the British mandate, especially at Lake Huleh and in the Jordan Valley; but with the lifting of the central authority, it is to be feared that animal life will suffer from the extensive use of rifle and poison before law and order restore close seasons, game reserves and the control of fire-arms, which are essential if the large mammals like the leopard, ibex, wolf, cheetah and gazelle are to survive.

AFFORESTATION AS A WORLD PROBLEM

IN a brochure entitled "Forestry and Forest Products—World Situation 1937–1946", issued by the Food and Agriculture Organisation of the United Nations, a graphic exposition of the world's position was produced (see *Nature*, May 8, p. 710). Prof. H. G. Champion, professor of forestry, University of Oxford, also discussed this theme in a paper entitled "Afforestation as a World Problem" before the Royal Society of Arts on March 17. In this paper he discussed various aspects of forestry and forestry work. As he correctly says, "the majority of us pay little attention to the changes which have taken place in the past in the natural vegetation which covers most of the land not taken up by buildings, roads, gardens, mines or agricultural crops. We are barely conscious of the fact that in Britain almost every acre of cultivation and bare land—except on the hill tops and in the fens—has been cleared from the forest which once covered nearly the whole surface. From being a country almost entirely under forest, England has now a lower proportion than any other country in Europe." How often did a predecessor of Prof. Champion's at Oxford, Sir William Schlich, point this out to a deaf Government?

The respective positions of Western European countries, as shown by figures given by the Food and Agriculture Organisation, are contrasted. The interesting position of the Middle East, contrasted with its position in Biblical and Roman times, is discussed; also that of America, Central and South Africa and Australia. Here the picture is chiefly one of ruthless destruction of the forests, either in the interest of agriculture or stock raising, or due to the habits of the local and introduced populations of annual unchecked firing of the countryside for whatever purpose, and over-grazing. Such actions have produced serious conditions in temperate climates. In the tropics they are devastating. For example, Prof. Champion states that in Nigeria it has been

estimated that 1,000 square miles of forest are being destroyed by shifting cultivation annually. This type of affairs is proceeding throughout many parts of Africa in British, French, Belgian and Portuguese Colonies. The author contrasts the nature of the vegetation which may clothe the soil when the forest is removed "if, indeed, the soil does get or retain a cover at all". Temperate and tropical conditions are dealt with. Prof. Champion particularly stresses grazing of domestic cattle and the damage caused. "In all but the wet tropical forests, grazing is liable to be second only to direct human action as a forest-destroying agency", a statement which must be known now throughout the world, though still requiring emphatically re-stating. Protection of endangered existing forest areas by closure, re-afforesting and so forth are the remedies which are imperative in many parts of the world.

As the report of the Food and Agriculture Organisation stressed, production is not the only aim of the forester. Indirect effects of the presence of the forest on a countryside are also aimed at, and one of the vital ones is protecting the forest or rebuilding a forest to check erosion, shelter agricultural lands and stock and so forth, and the protection of all water catchment areas, including the head waters of streams and rivers.

Finally, Prof. Champion considers the immediate objectives of the larger afforestation undertakings of the world under seven heads: briefly, stabilization of moving sands, increasing local supplies of timber and fuel, stoppage of erosion on hillsides through avalanches and of areas on hills liable to ravine formation, protection by forests or woodland belts of agricultural land and stock and buildings, re-afforesting of waste land and growing timber to supply industries for export trade or to maintain or build up stocks at home. These are discussed in some detail in the paper.

SOUTH AFRICAN COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

THE second annual report of the South African Council for Scientific and Industrial Research (Block 1, Central Mint, Pretoria) covering the year ended October 5, 1947, refers to progress in establishing the Council's national laboratories and services as exceeding expectation in many respects, although it will still be several years before all are fully working. Four industrial research associations, covering the leather, fish, paint and sugar-milling industries, are now in being and proposals for a fifth, to deal with the clay and ceramic industries and others interested in silicates, are being discussed. During its first two years the Council has signed contracts for twenty investigations for industrial and other sponsors to a value of £13,968, and of these seven have been completed. Arrangements for the support of research in universities and similar institutions operated satisfactorily during the year, but it is probable that the Council will have to consider further means of assisting the universities to provide the large number of scientific men and women of high qualifications which will be required.

The work of the Library and Information Division increased greatly during the year. The Library now includes about 70,000 books, pamphlets and reports on all branches of science and technology. A draft guide to authors in the preparation of abstracts has been prepared for the use of South African scientific periodicals the abstracts of which will be distributed overseas. The functions of the three main divisions of the National Building Research Institute have been more sharply defined, and sub-division of the Engineering Division into three sections—engineering, materials, and soil mechanics—is already visualized. The services of the soil mechanics section are already in embarrassing demand. Details of some forty-two projects in which work is already proceeding are given in the report, and among these may be mentioned foundation design for small houses, soil-cement construction, a study of expansive mortar failures in brickwork, standardization of wear-test for flooring, termite-proofing of buildings, comfort standards, tests for the thermal properties of building materials, roof ventilators, ventilation and natural lighting of buildings and a study of native housing.

Considerable progress has been made with the National Physical Laboratory, where the Spectrographic Section has made a satisfactory start. Work has already been commenced on the design and construction of instruments for aptitude testing, the measurement of soil pressures, the use of supersonic waves as a bactericide and on general acoustics. The Telecommunications Research Laboratory has measured and studied the characteristics of the ionosphere, and work on the measurement of radio noise-levels was contemplated. Measurements have been made of the propagation of radio waves in the Witwatersrand gold mines, and a micro-wave radar set has been developed for tracking thunderstorms. At the National Chemical Research Laboratory, the Microbiological Section, working at the Onderstepoort Laboratories, has investigated new yeast-like organisms from the rumen ingesta of sheep, and work is proceeding on the determination of degradation products arising from the action of moulds on wattle tannin extract. The fats, waxes, and proteins unit has been concerned with investigations on pilchard oil, the vitamin A content of liver oil from soupfin sharks and on marine fats.

Under the National Bureau for Personnel Research, the three main projects have covered selection and classification tests for operatives in the clothing industry, classification tests for native miners and 'boss-boys', and personnel research for the Union Defence Force. The development of screening and aptitude tests for the engineering branch of the G.P.O. continued during the year. A Liaison Division was formed during the year to provide liaison between the Council's laboratories and industry, including the handling of technical inquiries, visits to industrial firms and the organisation of co-operative research in industry. This Division is also responsible for handling contracts for sponsored research and the overseas scientific liaison offices and missions.

Seven senior bursaries or fellowships were awarded by the Council during the year to enable South Africans of outstanding ability and experience to carry out at least a full year of unencumbered research. Three senior bursaries were also awarded for research in the medical field, and details of these ten awards are given in the report. Twelve bursaries of £200 a year were also awarded for postgraduate research and five others for postgraduate medical research, and eighteen bursaries of £100 a year to undergraduate research students.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, June 7

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 8.15 p.m.—Dr. T. Paterson: "Explorations in the Canadian Arctic".

Tuesday, June 8

RESEARCH DEFENCE SOCIETY (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 3.15 p.m.—Annual General Meeting: Prof. P. A. Buxton, F.R.S.: "Tsetse Flies and the Development of Africa" (Seventeenth Stephen Paget Memorial Lecture).

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.2), at 5 p.m.—Prof. Pie Laviosa Zambotti: "The Origin and Diffusion of Civilization".

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

Wednesday, June 9

PHYSICAL SOCIETY, COLOUR GROUP (at the Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 3.30 p.m.—Mr. R. W. G. Hunt: "The Effects of Daylight and Tungsten Light Adaptation on Colour Perception".

INSTITUTE OF PETROLEUM (at 26 Portland Place, London, W.1), at 4 p.m.—Scientific Papers.

MANCHESTER STATISTICAL SOCIETY (at the Reform Club, King Street, Manchester), at 5.30 p.m.—Annual General Meeting.

Thursday, June 10

CHADWICK PUBLIC LECTURE (at the Chelsea Physic Garden, Swan Walk, London, S.W.3), at 4 p.m.—Prof. Frederick G. Gregory: "The Factors Controlling Reproduction in Plants".*

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Dr. V. B. Wigglesworth, F.R.S.: "Insects as a Medium for the Study of Physiology" (Croonian Lecture).

Friday, June 11

FERTILISER SOCIETY (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 2.30 p.m.—Dr. W. G. Ogg: "Fertilisers in the National Economy".

PHYSICAL SOCIETY, OPTICAL GROUP (in the Physics Department, Imperial College of Science, Imperial Institute Road, London, S.W.7), at 3 p.m.—Mr. T. Smith, F.R.S.: "The Computation of Large Numerical Aperture Telescope Objectives": Prof. L. C. Martin: "The Boundary Wave Theory of Image Formation".

Saturday, June 12

BRITISH PSYCHOLOGICAL SOCIETY (in the Hastings Hall, Tavistock House, Tavistock Square, London, W.C.1), at 2.30 p.m.—Prof. A. B. Fitt: "Is Development Affected by the Season of Conception?"

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at the London School of Tropical Medicine and Hygiene, Keppel Street, London, W.C.1), at 2.30 p.m.—Discussion on "Substances of High Permittivity".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER (Grade III) IN THE DEPARTMENT OF CHEMISTRY, with special qualifications in inorganic and physical chemistry—The Clerk, Birkbeck College, Breams Buildings, London, E.C.4 (June 12).

LECTURER IN CIVIL ENGINEERING—The Registrar, The University, Leeds 2 (June 14).

SOIL SURVEY OFFICERS in the Gold Coast to supervise the collection of information about the soils of the forest region in that territory—The Director of Recruitment (Colonial Service), Colonial Office, 15 Victoria Street, London, S.W.1 (June 15).

AGRICULTURIST in the Southern Rhodesia Government Service—The Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (June 15).

LECTURERS IN PHYSICS, ZOOLOGY, BOTANY, CHEMISTRY and MATHEMATICS, in the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (June 15).

DEMONSTRATOR IN THE DEPARTMENT OF ZOOLOGY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (June 18).

ASSISTANT TECHNICAL OFFICERS (temporary) in the Agricultural Lime Department of the Ministry of Agriculture and Fisheries—The Ministry of Labour and National Service, Technical and Scientific Register, Section K, York House, Kingsway, London, W.C.2, quoting G.186/48A (June 21).

LECTURER IN PLANT PHYSIOLOGY, a LECTURER IN MATHEMATICS, and a LECTURER IN BOTANY (Bacteriology)—The Registrar, University College of South Wales, Cathays Park, Cardiff (June 21).

ASSISTANT POULTRY OFFICER (male), in the Department of Agriculture and Lands, Government of Southern Rhodesia—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (June 23).

LECTURER IN MATHEMATICS in the United College, St. Andrews—The Secretary, The University, St. Andrews (June 30).

LECTURER IN PHYSICAL CHEMISTRY, and a LECTURER IN PHYSIOLOGY, in University College, Dundee—The Secretary, The University, St. Andrews (June 30).

UNIVERSITY LECTURER and UNIVERSITY DEMONSTRATORS (2) IN CHEMICAL ENGINEERING—The Secretary, Appointments Committee of the Department of Chemical Engineering, Chemical Laboratory, Cambridge (July 1).

LEVERHULME RESEARCH STUDENTSHIP for research into some aspect of the history or archæology of London—The Secretary, London Museum, Lancaster House, St. James's, London, S.W.1 (July 1).

LECTURER IN MECHANICAL ENGINEERING in the University of Melbourne—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (July 1).

PROFESSOR OF MECHANICAL ENGINEERING, and a PROFESSOR OF BOTANY, at the University of the Witwatersrand, Johannesburg—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (July 31).

SOIL ANALYST in the Soil Survey Branch of the Agricultural Department of the Gold Coast—The Director of Recruitment (Colonial Service), Colonial Office, 15 Victoria Street, London, S.W.1.

ASSISTANT and ASSOCIATE PROFESSORSHIPS IN THE DEPARTMENT OF PHYSICS—The Head, Department of Physics, University of British Columbia, Vancouver, B.C., Canada.

JUNIOR LABORATORY TECHNICIAN IN THE PATHOLOGY LABORATORY—The Secretary, Marie Curie Hospital, 66 Fitzjohn's Avenue, London, N.W.3.

FIELD OFFICER by the East Africa High Commission in the Inter-territorial Tsetse Reclamation Department—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.21363/3F.

YOUNG ENGINEER or SCIENCE GRADUATE to assist in the administration of research programmes on the manufacture and use of wrought steel—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, endorsed 'Wrought Steel'.

DEMONSTRATOR IN THE DEPARTMENT OF CHEMISTRY—The Registrar, University College, Singleton Park, Swansea.

LABORATORY TECHNICIAN IN THE DEPARTMENT OF CHEMISTRY—The Secretary, University College, Gower Street, London, W.C.1, quoting Chemistry/4.

METALLURGIST for investigation of problems in welding of structural alloy steels—The Director of Research, British Welding Research Association, 29 Park Crescent, London, W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Liverpool Council of Social Service. Youthful Lawbreakers: a Study of Juvenile Delinquency in Liverpool made by the Department of Social Science of the University of Liverpool. Pp. 47. (Liverpool: University Press of Liverpool, 1948.) 2s. 6d. net. [194

Medical Research Council. Special Report Series, No. 263: Fatty Liver Disease in Infants in the British West Indies. By Dr. J. C. Waterlow. Pp. 84 + 12 plates. (London: H.M. Stationery Office, 1948.) 2s. net. [194

British Standard 1170: 1947. British Standard for Treatment of Water for Marine Boilers (with a Section on Engineering Factors). Pp. 96. (London: British Standards Institution, 1947.) 10s. 6d. net. [196

The Church and the Atom: a Study of the Moral and Theological Aspects of Peace and War. Pp. 130. (London: Church Assembly, 1948.) 4s. [226

Rheology in Relation to Pharmacy and Medicine. By Dr. G. W. Scott Blair. Pp. 20. (London: Pharmaceutical Press, 1948.) 2s. [226

List of Whole-time Awards for Scientific Research offered by Public and Private Bodies in the United Kingdom. Fifth issue. Pp. 48. (London: Royal Commission for the Exhibition of 1851, 1948.) 1s. [274

Psychology at Work. Vol. 1, No. 1, March 1948. Pp. 28. (London: National Institute of Industrial Psychology, 1948.) N.p. [274

Public Administration To-day. By Prof. William A. Robson. Pp. v + 26. (London: Stevens and Sons, Ltd., 1948.) 2s. 6d. net. [274

Acta Crystallographica. (Published for the International Union of Crystallography.) Vol. 1, Part 1, March 1948. Pp. 48. (Cambridge: At the University Press, 1948.) 10s.; 50s. per vol. [274

British Standard 1000A: 1948. Universal Decimal Classification. Abridged English edition. Pp. 128. (London: British Standards Institution, 1948.) 25s. net. [294

Enquiry. (Monthly.) No. 1, April 1948. Pp. 32. (London: Horace Cox, Ltd., 1948.) 1s. 3d.; annual subscription, 16s. [294

Ministry of Education: Science Museum. Darkness into Daylight: an Account of the Past, Present and Future of Man-made Illumination. Pp. v + 34 + 12 plates. (London: H.M. Stationery Office, 1948.) 1s. net. [35

Other Countries

Undersökningar över Öresund. 35: On the Smaller Arthropoda of Marine Algae, especially in the Polyhaline Waters off the Swedish West Coast. By Erik Dahl. Pp. 193. (Lund: C. W. K. Gleerup, 1948.) [274

Annals of the New York Academy of Sciences. Vol. 49, Art. 3: Bioluminescence. By E. Newton Harvey, Rubert S. Anderson, John B. Buck, Aurin M. Chase, Henry Eyring and Frank H. Johnson. Pp. 327–482 + 5 plates. (New York: New York Academy of Sciences, 1948.) 2.50 dollars. [294

Deccan College Monograph Series. 2: Anthropometric Measurements of the Marathas. By Mrs. Irawati Karve. Pp. 72 + 9 plates. (Poona: Deccan College Post-Graduate and Research Institute, 1948.) 8 rupees. [294

Carnegie Institution of Washington. Publication 579: The Solar Spectrum, λ6600 to λ13495. By Harold D. Babcock and Charlotte E. Moore. Pp. iii + 95. (Washington, D.C.: Carnegie Institution, 1947.) 1.40 dollars. [35

Kungl. Lantbrukshögskolans Annaler (Annals of the Royal Agricultural College of Sweden). Vol. 15. Pp. v + 349. (Uppsala: Almquist and Wiksells Boktryckeri A.-B., 1948.) [35